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CSI Resource Systems, Inc.
Boston MA

Prepared for

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This report presents a Phase II study as followup of a Phase I site-visit made to the City of Port Orange, Florida, on October 11, 1979. Based on the findings of Phase I, this report embraces the following objectives:

1. Assess the existing Port Orange Collection System (POCS) (crew sizes, work distribution, routing, waste volumes, etc.).
2. Evaluate cost-effective collection methods.
3. Assess separation of lawn clippings.

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A TECHNICAL ASSISTANCE PROGRAM REPORT

TECHNICAL ASSISTANCE TO THE CITY OF PORT ORANGE, FLORIDA

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RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Project Officer: Elmer G. Cleveland

U. S. ENVIRONMENTAL PROTECTION AGENCY

TECHNICAL ASSISTANCE PROGRAM REPORT SERIES

TECHNICAL ASSISTANCE TO THE CITY OF PORT ORANGE, FLORIDA

PREPARED FOR:

OFFICE OF SOLID WASTE MANAGEMENT

U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION IV, ATLANTA, GEORGIA

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CHAPTER 1

SUMMARY AND CONCLUSIONS

CHAPTER 1

SUMMARY AND CONCLUSIONS

The City of Port Orange, Florida, is a primarily residential community of approximately 17,000 persons. It is located in Volusia County, southwest of Daytona Beach, Florida. Roughly one-half of the city's population are retired senior citizens.

Port Orange provides solid waste collection services for the residences and commercial establishments within the city limits. The Port Orange Garbage and Trash Department (POG&TD) is currently responsible for servicing approximately 7,600 residential units and 90 commercial accounts. The City contacted the EPA Region IV Office of Solid Waste Management and requested technical assistance in evaluating its solid waste collection system. In response to the request, a Phase I site visit was made on October 11, 1979, in which the following problem areas were identified:

- The equipment used by the POG&TD was old, costly to maintain, non-standardized and there was no consistent policy for equipment replacement.
- The City has been experiencing a rapid growth rate in excess of 20% per year (Port Orange population increased 109% between 1975 and 1979) and the practice for adjusting to the additional garbage and trash pick-ups has lacked a systematic or rule-of-thumb procedure. Consequently, the City feels its collection costs have risen disproportionately to the growth of the city.
- The garbage collected in Port Orange contains an unusually high proportion of grass and lawn clippings. The City has experienced problems in the incineration of the grass.

- The City maintains an incentive program whereby the collection personnel are allowed to leave after finishing the tasks associated with their specified routes. The City desired assistance in evaluating the efficiency and productivity of the personnel and conducting an evaluation of the existing task-incentive program.

The problems facing the POG&TD have been changing over the course of the study. The City has discontinued solid waste incineration and has begun landfill disposal of all solid waste. The City has also purchased four new collection vehicles. However, the basic scope of the project has remained unchanged, i.e., to provide technical assistance to the City so that it may optimize the operation and cost effectiveness of its solid waste collection system.

Based on the problems identified in the Phase I site visit the Technical Assistance to The City of Port Orange, Phase II project was approved.

The specific objectives of the Phase II study are itemized below:

- Assess the existing Port Orange Collection System (POCS) by a) examining the present collection methods, crew sizes, work distribution, equipment, routes, waste volumes and system capacity, and b) evaluating the performance and cost effectiveness of the system and comparing performance parameters with other operating systems and with technically accepted collection practices.
- Evaluate alternative methods of collection which may decrease the cost and increase the efficiency of collection. Alternative routing schemes, personnel staffing, equipment and collection methodologies are to be investigated to determine the feasibility of implementation.
- Assess the feasibility of segregating the lawn clippings by determining the technical and economic advantages of separate disposal of the lawn clippings.

The work associated with this study has been completed. A summary of the information that was developed during the course of the study and major conclusions of the study are presented in this chapter. The

details of the various aspects of the study are briefly presented in the following sections and discussed in more detail in Chapters 2 and 3. Appendix A contains the labor and equipment cost calculations.

1. POCS PERFORMANCE

The POCS provides twice per week, curbside garbage collection service to the residents of Port Orange. Trash (yard wastes, etc.) is also collected once per week from each resident. Commercial locations are also serviced one or more times per week depending upon the amount and type of refuse being produced. The four residential crews utilize one driver and two walkers and the commercial crew uses one driver and one walker. An analysis was performed to determine the productivity of the POCS (four days per week garbage collection only). The details of the productivity analysis are presented in Chapter 2 . The basic data used for this analysis consisted of measurements of per crew task time and time spent on necessary non-productive tasks (land fill trips, etc.) from daily log sheets and per route house counts. The productivity analysis produced an estimated average per crew productivity for the POCS of 206 pick-ups/crew-hr (based on on-route time). These estimates were the result of a productivity analysis on the entire system.

2. EVALUATION OF POCS SYSTEM PERFORMANCE

The POCS was evaluated by comparing its productivity and cost effeciency with those of other systems offering the same basic level of service (referred to as the Comparison Systems). The Comparison Systems were the subject of a detailed one-year EPA study to evaluate these systems' productivity.(1) The Comparison Systems were selected by the EPA as being "highly productive" and only the four most efficient crews from each system were monitored. The POCS is similar to the the Comparison Systems in many ways but does differ based on crew size (except System C), equipment type and collection methodology. The details of the comparison are given in Chapter 2. The findings and conclusions from the productivity and cost efficiency comparisons are

(1)USEPA, "Residential Collection Systems", EPA/530/SW-97c.1, March, 1975

given below.

2.1 The per walker productivity of the POCS (103 pick-ups/walker-hr) was found to be similar to the per walker productivities of the Comparison Systems (average 106 pick-ups/walker-hr). It was concluded that the POCS and the Comparison Systems are directly comparable on a per walker productivity basis since the walkers' tasks are similar for all of the systems.

2.2 The per crew productivity of the POCS was found to be greater than those of the Comparison Systems. For Comparison Systems A and B this is due to the fact that the POCS uses a larger crew and has similar per walker productivities. The fact that the POCS per crew productivity is greater than Comparison System C indicates that the POCS is slightly more efficient.

2.3 The unit services cost (cost per home served per week) of the POCS was found to be lower than those of the Comparison Systems (based on a comparison using equivalent item costs). It was concluded that the four systems are directly comparable on a cost efficiency basis because they all offer the same nominal level of service.

2.4 Based on the comparative analysis it is concluded that the POCS, as presently operated, is a highly productive and cost efficient refuse collection system when compared to other systems offering the same nominal level of service.

3. SYSTEM IMPROVEMENT ALTERNATIVES

Cost reduction alternatives utilizing equipment changes, level of service changes, crew size changes, schedule changes and routing changes were investigated in Chapter 3. The following conclusions were formulated.

3.1 The potential for substantial cost savings through a level of service change from twice-per-week collection to once-per-week collection exists, although the probability of creating a health hazard due to the Port Orange climate would negate any cost reduction benefits. Therefore, a change in the level of service is not recommended.

3.2 A change in the size of the crews used in the POCS would probably not improve the cost effectiveness of the system. When comparing the

POCS crews with highly productive smaller crews it was found that the POCS costs were less (based on a comparison using equivalent item costs). A reduction in crew size would also require increased task time and subsequently excessive overtime pay. An increase in crew size to 4 persons has been found to be uneconomical due to the fact that the additional walker is not fully utilized and slows the other walkers by crowding the working area behind the packer. Therefore, a change in crew size is not recommended for the POCS.

3.3 The potential for cost savings through a schedule change is highly probable for the POCS. By combining garbage and trash collection and working a four-day week rather than a five-day week the equipment costs would be reduced because the route would be travelled only twice per week, rather than three times per week. The fact that the garbage and trash collection together would take less total time than separate collection is also highly probable and could provide the system with a greater capacity for expansion.

3.4 The existing macro-routing or area of responsibility for each POCS crew was found to be well balanced among the crews. Subsequent additions to each route should be made with regard to the total task time involved. POG&TD personnel will need to keep track of total task times for each crew on a regular basis. When the task times become excessive or the productivity of a crew drops adjustments in the overall macro-routing of the City will be necessary to maintain equitable divisions of work and high productivity.

3.5 The POCS currently has no specific routes for the drivers to follow within their daily collection areas. Using heuristic routing techniques, the areas of responsibility for each crew have been analyzed and a driving route (micro-route) has been developed that will minimize backtracking and non-productive distances and thereby improve crew productivities and reduce equipment operation and maintenance costs. These specific routes are shown in Chapter 3. As additional units are added to each route it is necessary to adjust each micro-route so as to minimize backtracking and non-productive travel. It is believed that the use of

these micro-routes in Port Orange will increase the productivity and capacity of the system.

3.6 Due to the recent purchase of four new collection vehicles excessive maintenance should be reduced and operating cost should be lower for the POCS. POG&TD personnel should keep records of equipment operation and maintenance costs to aid in determining when replacing vehicles will be more cost-effective than maintaining old vehicles. When vehicle replacement becomes apparent an evaluation of the cost effectiveness of alternative equipment usage should be done to determine the most efficient vehicle type for the POCS. An example using existing POCS parameters has been shown in Chapter 3. The same methodology should be used to determine future equipment types at replacement time.

3.7 Two-way radios should be added to all the collection vehicles in order to provide on-route communication with all crews in order to minimize lost time due to backtracking and breakdowns and to allow immediately response in the event of an accident or injury.

3.8 Because of the recent shut down of the incinerator in Port Orange the lawn clippings are no longer an immediate problem for POG&TD personnel. Composting of yard wastes in the United States has not been successful in the past and is not recommended for Port Orange for two reasons. One, the use of composting for volume reduction only is not economically viable, and two, according to City of Port Orange management personnel there is no market in the area for compost. Therefore, it is recommended the POCS crews continue hauling yard wastes to the county landfill.

3.9 The use of the existing incinerator site as a transfer station was found to be more costly than direct haul by the packer vehicles and is therefore, not recommended.

As a result of this study it is recommended that the City of Port Orange take the following steps to improve the productivity and cost efficiency of the POCS.

- Institute combined garbage and trash collection and a ten hour four-day-per-week work week to minimize equipment operation costs and probably increase the system's capacity.

- Utilize the micro-routes devised for each route and keep track of total task time and productivity to aid in the adjustment of the existing micro-routes as the city grows.
- Keep detailed operation and maintenance records to determine cost effective equipment replacement periods and minimize overall equipment cost. Evaluate alternative equipment types when equipment replacement becomes necessary.
- Add two-way radios for on-route communication with each crew.

CHAPTER 2

CURRENT COLLECTION SYSTEM DESCRIPTION AND EVALUATION

CHAPTER 2

CURRENT COLLECTION SYSTEM DESCRIPTION AND EVALUATION

The objective of this chapter is to present information concerning the characteristics of the Port Orange Collection System (POCS) as it is presently structured and operated. The POCS is also evaluated with respect to productivity and cost efficiency and the results are compared with EPA findings for highly productive collection systems offering the same nominal level of service as Port Orange. This evalulation and subsequent comparison presents meaningful data necessary to determine whether or not the POCS is a productive and cost efficient collection system.

SYSTEM DESCRIPTION

Residential and commercial solid waste is collected by the Port Orange Garbage and Trash Department (POG&TD) and disposed of at the Volusia County Landfill. This landfill is approximately eleven miles from the city. The collection system currently services approximately 7,690 pick-up locations within the Port Orange City limits. The POCS can be divided into the following three areas:

- Household refuse (garbage) collection.
- Lawn clippings, yard wastes and miscellaneous refuse (trash) collection.
- Commercial container collection.

RESIDENTIAL GARBAGE AND TRASH COLLECTION SYSTEM DESCRIPTION

Garbage and trash collection services are provided for approximately 7,600 pick-up locations. The POG&TD provides a level of service as follows:

- Twice-per-week garbage collection from each residence.

- Once-per-week trash collection from each residence.
- Curbside service in all areas.
- Pick-up of bag and/or can containerized refuse.

At present the POCS operates with four residential collection crews and one commercial collecton crew. Each residential crew is responsible for garbage and trash collection on two routes. The crew, route and service breakdown is shown in Table 2.1. On Monday and Thursday, garbage is collected from one route; on Tuesday and Friday from the other route. On Wednesday each crew is responsible for trash pick-up and general clean-up on both routes.

The crews are made up of three persons each. One person is responsible for driving the collection vehicle and also acts as a crew chief. The other two crew members are responsible for loading refuse into the collection vehicle (walkers or pickers). As a rule drivers do not regularly help to load refuse. The drivers are paid at a higher rate than the walkers.

The POCS is presently operated on a task incentive system. Under this system, refuse collection vehicles leave the yard at approximately 8:00 a.m. The crews work their routes and make trips to the landfill as needed. When the tasks for the route are completed, the crews are free to leave work for the day. The basis of the incentive program is that the personnel are paid for 8 hours of work per day, 5 days per week regardless of how long it takes. It is estimated that the average per crew task time for the four residential routes is 6.4 hours per day. (See productivity analysis later in this chapter).

As previously stated, the POG&TD collects garbage and trash placed at the curbside by Port Orange residents. A one-pass method is used for street collection (i.e., refuse from both sides of the street is collected on a single pass). In this way the travel distance on-route is minimized.

Equipment

The POCS uses four rear-load type packer vehicles on a regular basis (not including the rear-load commercial collection vehicle) and has one spare rear-load vehicle for stand-by use. Each crew is assigned a packer and uses the same vehicle regularly unless there is an equipment failure.

TABLE 2.1

PORT ORANGE CREW AND ROUTE BREAKDOWN

RESIDENTIAL CREW[1]	ROUTE	PICK-UP DAYS	NUMBER OF SERVICE UNITS
A	1	M, TH	995
	8	T, F	890
B	2	M, Th	828
	7	T, F	908
C	3	M, Th	850
	5	T, F	1039
D	4	M, Th	850
	6	T, F	1233

[1]As of 10/80 the driver of Crew A is Franklin, Crew B is Hamaker, Crew C is Crockwell and Crew D is Pinckney.

Table 2.2 summarizes the POCS packer vehicle inventory. All of the vehicles currently in use are 20-cubic-yard rear loaders with conventional compacting mechanisms. The four vehicles used on the residential routes have all been purchased in the last six months. The commercial collection vehicle is one year older. Since the POG&TD has recently purchased these new collection vehicles, the operation and maintenance costs for the system should be lower in the immediate future (ignoring inflationary impacts) than over the past few years (although data do not exist to verify this projection).

COLLECTION SYSTEM PERFORMANCE

The performance of the POCS has been evaluated in terms of productivity and cost effectiveness. The purpose of this section is to present the results of the productivity analysis.

The productivity of a municipal refuse system is often expressed in the following terms:

- weight of refuse collected per crew per hour.
- number of residences (pick-ups) per crew per hour.

Common variations include per-crew member and per-walker expressions for productivity.

Weight collected productivity measurement (ton/crew-hr, etc.) requires weight records for the full refuse vehicles. Because refuse production rates can be highly variable over short periods, it is necessary to collect a considerable number of weight measurements over an extended period of time to develop a statistically meaningful data base. A task of this magnitude was beyond the scope of this study. Other methods of productivity measurement will be used here and weight measurements are not necessary to achieve the objectives of this study.

Productivity was measured in terms of services provided for the purposes of this analysis. These measurements can be made much more easily and more accurately than weight measurements over a short period of time. The basic unit of productivity which is used here is "pick-ups/crew hr". This is an expression for the average number of pick-ups each crew or group of crews is making per on-route hour. It is important

TABLE 2.2

PORT ORANGE COLLECTION EQUIPMENT

VEHICLE TYPE	PACKER TYPE	PURCHASE DATE	SERVICE USE
FORD L-N 8000	Heil-20 Yd.	7/79	Commercial
FORD L-N 8000	Heil-20 Yd.	10/80	Residential
FORD L-N 8000	Loadmaster-20 Yd.	6/80	Residential
FORD L-N 8000	Loadmaster-20 Yd.	6/80	Residential
FORD L-N 8000	Loadmaster-20 Yd.	6/80	Residential
GMC	Loadmaster-20 Yd.	1973	Stand-by

remember that, in this case each home is serviced twice per week (i.e., homes served/crew-hr is equal to one half the pick-ups/crew-hr). To avoid confusion pick-ups/crew-hr, pick-ups/crew member-hr, or pick-ups/walker-hr will be used exclusively here.

Two basic pieces of information are needed to determine system productivity:

- The average time spent on route on a daily basis.
- The average total number of pick-ups or units served on a daily basis.

In this case the necessary time measurements were made by having the collection vehicle drivers keep daily log sheets. A blank log sheet is shown as Figure 2.1. The data were collected intermittently over a six-week period and are believed by POG&TD Supervisory personnel to be relatively accurate. From the completed data sheets it was possible to calculate the amounts of time that were spent on travel to and from the route, to and from the landfill and on-route collection. The drivers also noted mileages for the various activities. The data sheets had blanks for house counts and fuel usage, but this information was not recorded in most cases. The number of homes being served on each route was provided by the POG&TD supervisory personnel after making a visual count on each route and the average fuel costs were provided in the POG&TD annual budget.

Table 2.3 shows the results of the POCS productivity analysis for the residential routes. Also shown are the basic data which were used to calculate the productivities of the collection crews. It is important to note that the productivity has been analyzed for four-day-per-week garbage collection only. Based on this analysis it is estimated that the productivity of the POCS ranges from 175 pick-ups/crew-hr to 231 pick-ups/crew-hr with the system average being 206 pick-ups/crew-hr. The average per-crew member productivity ranges from 58 pick-ups/hr to 77 pick-ups/hr.

The variability in the per-walker productivity that was observed in Port Orange could be due to one or both of the following factors:

- An actual difference in the rate at which the individual

FIGURE 2.1

CITY OF PORT ORANGE, FLORIDA
SOLID WASTE COLLECTION SURVEY

Date _____ Driver/Supervisor _____

Route _____ Walkers _____

Crew _____

ACTIVITY	TIME	MILEAGE
Leave Incinerator		
Arrive on Route		
Leave Route		
Arrive at Incin. or Landfill		
Leave Incin. or Landfill		
Arrive on Route		
Leave Route		
Arrive at Incin. or Landfill		
Leave Incin. or Landfill		
Arrive on Route		
Leave Route		
Arrive at Incin. or Landfill		
Leave Landfill		
Arrive at Incinerator		

Homes Served or Commercial Pick-Ups (Stick Count): _____

Gas Fill-Up _____

Gallons Gas _____

Gallons Diesel _____

NOTE: Please circle landfill or incinerator disposal site for each cycle.

TABLE 2.3

CITY OF PORT ORANGE COLLECTION CREW PRODUCTIVITY

CREW	ROUTE	AVERAGE TIME (hr/day) PRODUCTIVE[3]	($) NON-PRODUCTIVE	TOTAL[5] hr/day	HOMES[6] SERVED	CREW SIZE	PRODUCTIVITY[7] PICK-UPS/ CREW-HR	PICK-UPS/ CREW MEMBER-HR	PICK-UPS WALKER-HR
A	M-Th(#1)	4.3	1.7	6.0	995	3	231	77	116
	T-F (#8)	5.1	1.6	6.7	890	3	175	58	88
B	M-Th(#2)	3.8	1.5	5.3	828	3	217	72	109
	T-F (#7)	4.4	2.4	6.8	908	3	206	69	103
C	M-Th(#3)	4.6	1.5	6.1	850	3	185	62	93
	T-F (#5)	5.4	2.1	7.5	1039	3	192	64	96
D	M-Th(#4)	3.7	1.9	5.6	850	3	230	77	115
	T-F (#6)	5.6	1.8	7.4	1233	3	220	73	110

System Average Productivity: 7593 pick-ups/36.9 crew-hr = 206 pick-ups/crew-hr

7593 pick-ups/110.7 crew member-hr = 69 pick-ups/crew member-hr

7593 pick-ups/73.8 walker-hr = 103 pick-ups/walker-hr

(1) M-Th = Monday - Thursday route; T-F = Tuesday - Friday route.
(2) From data taken by collection crews during August and September, 1980.
(3) On-route collecting time.
(4) Time spent on breaks, travel to/from route and travel to/from landfill.
(5) Total from time crew leaves motor pool until crew returns to motor pool.
(6) Based on information provided by City of Port Orange personnel.
(7) Based on on-route time.

walkers are working.

- Physical differences between the routes that affect per-walker productivity.

The actual difference in the rate at which the walkers are working is dependent on two factors. The first is that the walkers often work at the pace which is set by the driver. If the driver is setting a slow pace the walkers are not likely to work as fast as when the driver was setting a faster pace by keeping ahead of the walkers. The second factor affecting the rate at which the walkers are working is a function of the efficiency the walker has developed through experience. In other words a person who has developed a consistent motion for picking up the waste containers and depositing the waste in the back of the packer will be able to collect more units per hour than a person who has not developed a consistent system or motion. While observations of the crews at work did not indicate a significant difference in the rate at which they were working, it is highly probable that on a routine basis these factors are contributing at least in part to the difference in per-walker productivity.

The other basic factor for the variability in productivity, physical differences in the routes, was examined to determine whether or not it appeared to have an impact on the per-walker productivity. Since Port Orange is basically flat, it is reasonable to assume that the most probable physical characteristic affecting per-walker productivity is housing density. The housing density affects the distance between homes in a residential area. A major time-consuming activity for the walkers in a curbside collection system is travel between houses. As the distance between houses increases this activity requires more time and effort. Using the data provided by the POG&TD and the crew data sheets, the number of pick-ups per on-route mile has been estimated. The per-crew productivity and per-walker productivity have been compared with the pick-ups per on-route mile (See Table 2.4) to determine whether there is in fact, a noticeable correlation.

TABLE 2.4

POCS PRODUCTIVITY AND PICK-UPS PER MILE COMPARISON

CREW	ROUTE	PRODUCTIVITY PICK-UPS/ CREW-HR	PRODUCTIVITY PICK-UPS/ WALKER-HR	AVG. ON-ROUTE MILES	PICK-UPS/MILE
A	1	231	116	16.6	60
D	4	230	115	15.5	55
D	6	220	110	22.4	55
B	2	217	109	18.4	45
B	7	206	103	21.6	42
C	5	192	96	14.7	58
C	3	185	93	19.8	43
A	8	175	88	30.7	29

Figure 2.2 shows this correlation graphically. It is evident that as the pick-ups per mile increase the per-walker productivity also increases. The only apparant deviation from this trend is Crew C's route number 5. This route is in an area of many long dead-end streets and consequently the walker's productivity could be lower due to excessive waiting for truck turnarounds. The graph clearly shows that both for a single crew and in general, the entire POCS as a whole is more productive when there are more pick-ups per mile. (i.e., when houses are closer together). This leads to the conclusion that the physical differences in the routes do affect the productivity of the crews in Port Orange.

EVALUATION OF RESIDENTIAL COLLECTION SYSTEM PERFORMANCE

Method of Evaluation

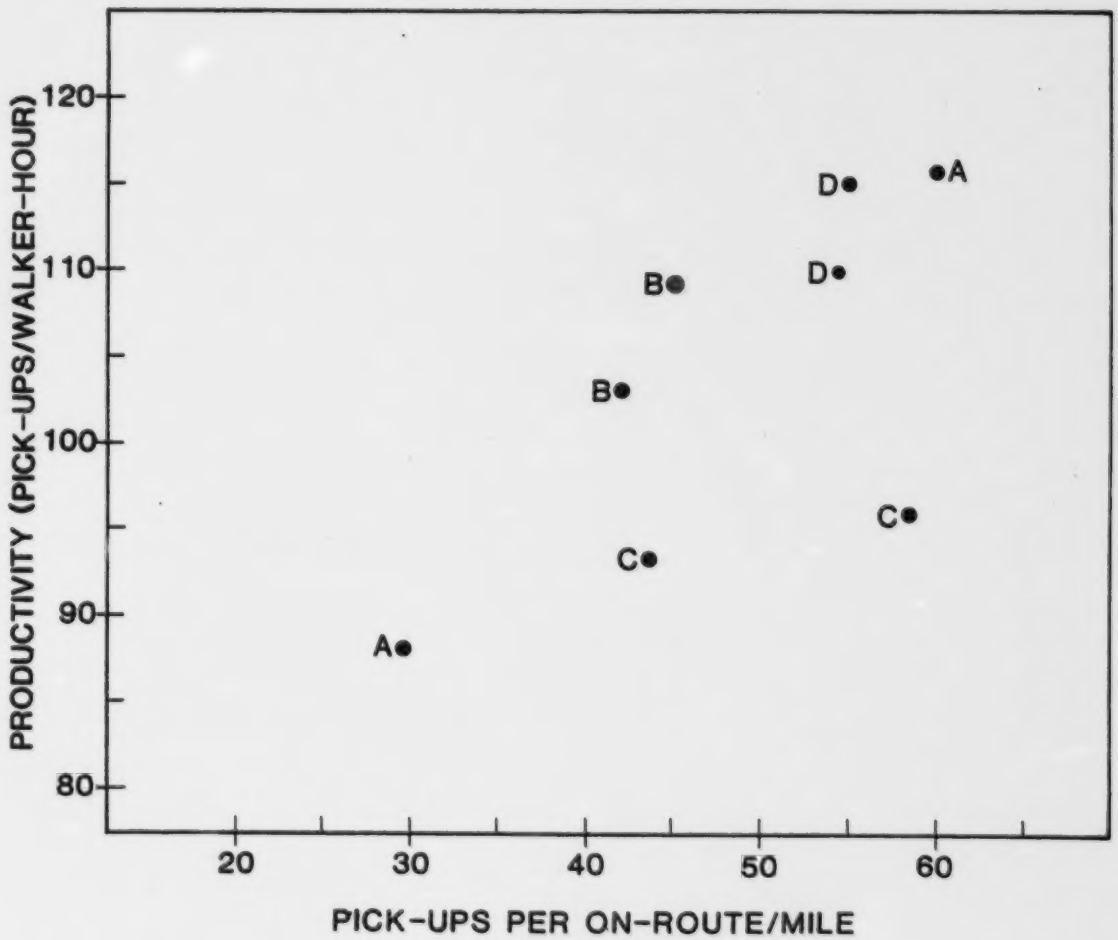
The relative productivity of a given refuse collection system can be estimated by comparing its productivity with the productivities of other operating systems (assuming a similar level of service). This approach was used in this study.

In 1975 the U.S. EPA published the results of a detailed study of 11 municipal collection systems ("Residential Collection Systems", EPA/530/SW-97c.1, March, 1975). The study monitored day to day operation of the systems for a 1-year period and evaluated year round productivity. The following quotation from the summary section of the study report sums up the goals and achievements of the study. "A concerted effort was made to select only highly productive systems for this study. The study data, then, represent reasonable productivity targets for similar systems. It is expected that this information will give residential solid waste collection managers everywhere a valuable tool for appraising the productivity and cost efficiency of their operations." This study represents one of the best efforts to date of residential solid waste collection productivity analysis.

Three of the systems studied by the EPA are comparable to the POCS on a level-of-service basis. These systems will be referred to as the Comparison Systems and shall be identified as systems I, II and III. The basic system characteristics and operating parameters for the Comparison

FIGURE 2.2

GARBAGE COLLECTION PRODUCTIVITY
VS
PICK-UPS PER ON-ROUTE/MILE



Letters indicate POCS crews.

Systems and the POCS are presented in Table 2.5. The systems all offer the same basic level of service, i.e., twice-per-week collection with curbside alley placement. The systems will not be directly comparable on a per-crew productivity basis because they all use different crew sizes. However, since the tasks of the walkers are similar for all the systems, they will be directly comparable on a per-walker productivity basis. Also, because the basic level of service is constant, the Comparison Systems will be directly comparable with the POCS on a cost efficiency basis. It can be seen from Table 2.5 that the operating parameters for the systems (operating agency, incentive system, containerization) are the same except for equipment types and collection methodology. However, in general it can be said that the equipment types are compatible with the crew sizes, and each system's collection methodology is compatible with its equipment type. The information necessary to determine if other similarities exist (topography, weights collected, etc.) is not presently available.

Evaluation of Productivity

Several measures of productivity for the City of Port Orange Collection System and the Comparison Systems (I,II,III) are given in Table 2.6. The development of the POCS productivity estimate was previously discussed. The productivity for the Comparison Systems was measured during the 1-year EPA Study.

As might be expected, the per-crew productivity shown in Table 2.6 increases with increasing crew size. This occurrence is illustrated in Figure 2.3. Because the POCS and System C have the greatest number of persons per crew they have the highest per-crew productivity. On the other hand, the per-walker productivity for the POCS is similar to that of the Comparison Systems (103 and 106, respectively).

Evaluation of Cost Efficiency

Productivity measurements are helpful tools for evaluating how well a given city's solid waste collection system is working. In general, productivity and cost efficiency are directly related. However, there

TABLE 2.5

OPERATING PARAMETERS FOR THE POCS

AND COMPARISON SYSTEMS

System[1]	Operating Agency	Crew Size[2]	Incentive System	Equipment[3] type	Collection Frequency	Collection[4] Methodology	Storage[5] Container	Container[6] Placement
I	public	1	task	side load	2/wk	one side	B&C	C/A
II	public	2	task	side load	2/wk	one side	B&C	C/A
III	public	3	task	rear load	2/wk	both sides	B&C	C/A
POCS	public	3	task	rear load	2/wk	both sides	B&C	C/A

(1) Data for systems I, II and III taken from "Residential Collection systems, Volume 1", EPA/530/SW-97c.1, U.S EPA, 1974.

(2) Includes drivers and walkers.

(3) Packer capacity varies.

(4) Both sides = both sides of street collected on one pass; one side = one side of street collected per pass (2-pass system).

(5) B&C = bags and cans.

(6) C/A = curb or alley.

TABLE 2.6

PRODUCTIVITY OF THE POCS AND COMPARISON SYSTEMS

SYSTEM (1)	PRODUCTIVITY (PICK-UPS MADE PER ON-ROUTE HOUR) PER CREW	PER CREWPERSON	PER WALKER
I (3)	84	84	84
II (3)	138	69	138
III (3)	201	67	100
POCS (2)	206	69	103

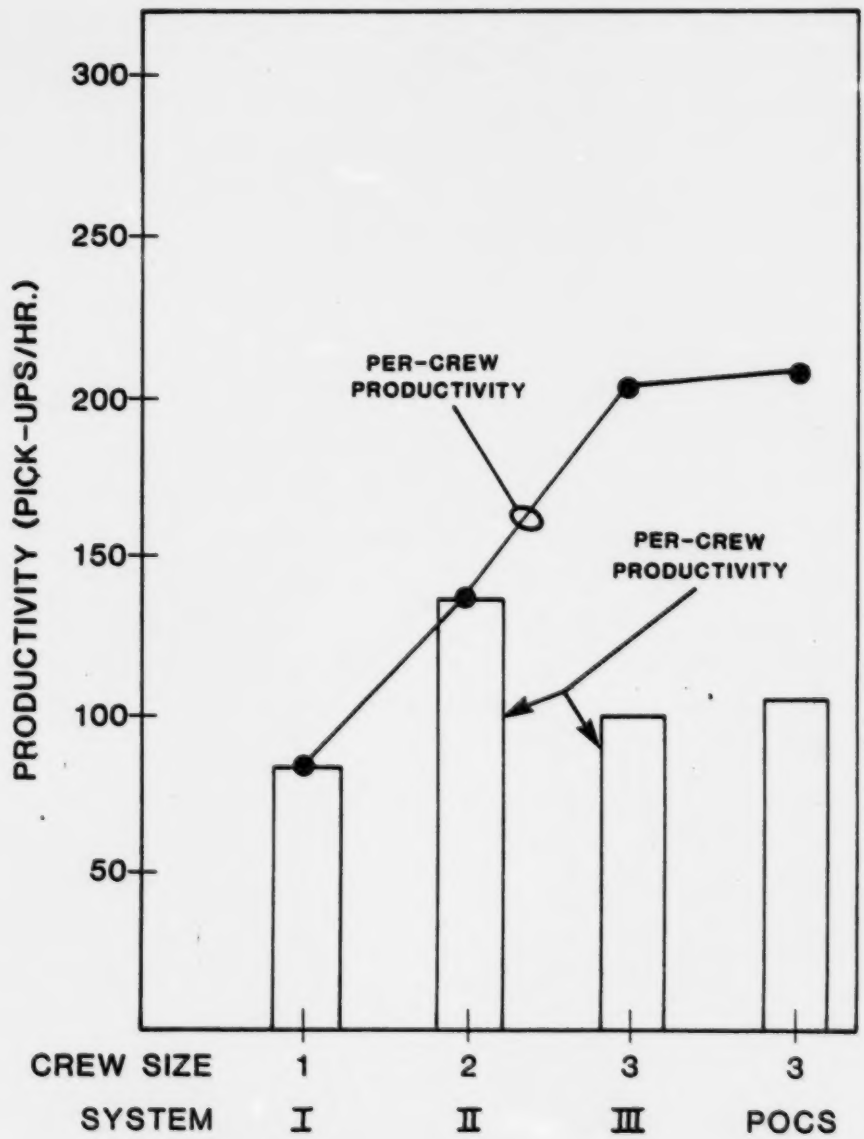
(1) Data for Systems I, II and III taken from "Residential Collection Systems; Volume 1", EPA/530/SW-97C.1, U.S. EPA, 1974

(2) Average for all Port Orange routes. See Table 2.3 for Port Orange productivity.

(3) Measured during 1-year EPA study. Driver is also Walker for System I.

FIGURE 2.3

PRODUCTIVITY FOR PORT ORANGE AND COMPARISON SYSTEMS



are instances where this is not so (usually when personnel and/or expensive equipment are being underutilized). The basic consideration of the performance of a collection system must be the economic efficiency of the system. The objective of this section is to evaluate the cost efficiency of the POCS and compare it to that of other highly productive solid waste collection systems.

A basic measurement of the cost efficiency of a given solid waste collection system is the cost per week of serving each home ($/home-week). Using such a parameter it is possible to compare systems whose total costs are completely different due to the sizes of the areas served. Cost efficiency was measured as follows:

1. Determine the average system per-crew productivity (P).
2. Determine the average productive time worked per week (T).
3. Calculate the average number of homes serviced per week (NH).

$$NH = 1/2\ P \times T$$

(note that the 1/2 factor accounts for twice per week collection from each home).

4. Determine the total per-crew weekly cost.

- PERSONNEL COST (PC)
  - wages
  - fringe benefits
  - personnel overhead

- EQUIPMENT COST (EC)
  - capital cost
  - debt service
  - maintenance
  - fuel and oil
  - replacement due to down time
  - loss of productivity due to equipment age

5. Calculate the system cost efficiency (CE).

$$CE = (PC + EC) / NH.$$

The cost efficiencies of the POCS and the Comparison Systems (I, II, III) were calculated. The cost efficiency of each system is comparable because the same cost basis was used. The costs are based on the

wages and equipment costs of the POCS:

Labor rates - Drivers $4.81/hr

Walkers $4.24/hr

Personnel Overhead - 16%

Fringe Benefits - 26%

Equipment Costs - Rear Loader $17,810/year.

(See life-cycle cost estimates contained in Appendix A).

Also, the average on-route time for the POCS was applied to all of the systems. It was thus determined how many homes each system could serve working at its own productivity rate for an equivalent number of hours.

The results of the cost efficiency analysis and comparison are shown in Table 2.7. It was found that the POCS was the most cost efficient of the systems analyzed.

Based on the productivity and cost efficiency analysis as well as the field observation made during this study the following conclusions have been formed:

- The performance of the POCS is, in general, equivalent to or better than other systems offering the same nominal level of service from a productivity and cost efficiency point of view.
- It is believed that the productivity and cost efficiency of the POCS can be improved by system changes in the following areas:
    - Level of service
    - Scheduling
    - Routing
    - Equipment Usage

These areas and other possible concepts for improving the performance of the POCS are evaluated in Chapter 3.

COMMERCIAL COLLECTION SYSTEM DESCRIPTION

The POG&TD provides commercial refuse collection service within the city limits. The commercial locations have one or more two, four or six-cubic yard containers which are serviced by the POCS commercial

TABLE 2.7

COST EFFICIENCY OF POCS AND COMPARISON SYSTEMS

System	Per Crew Productivity (Pick-ups/ crew-hr) [1]	Per-Crew Cost ($/wk) [2]			Average Productive Time [3]		Average Homes Served Per Week Per Crew [4]	Per Home Collection Cost [5]	
		Labor	Equipment	Total	hr/day	hr/week		$/wk	$/yr
I	84	274	274	548	4.6	18.4	775	0.71	36.9
II	138	516	274	790	4.6	18.4	1270	0.62	32.2
III	201	758	274	1032	4.6	18.4	1850	0.56	29.1
POCS	206	758	274	1032	4.6	18.4	1900	0.54	28.1

(1) Productivity for POCS based on actual productive (on-route) time measurements. Productivity for Systems I, II & III measured in 1-yr EPA study.

(2) Costs have been normalized to a comparable basis. Cost are for 4 working days/wk.

(3) Actual Productive time (on-route) for comparison Systems were 4.9 hr/day for I, 4.1 hr/day for II and 4.4 hr/day for III. POCS productive time is applied to all systems for comparison purposes.

(4) Two pick-ups per week for each home.

(5) Cost for garbage collection only. Does not include trash pick-up or landfill disposal cost.

container crew. In addition to commercial establishments, the commercial container crew also services the apartment complexes in the city.

The crew presently uses the 1979 rear-loader collection vehicle (see Table 2.2) and has one driver and one walker. The walker's reponsibility is to direct the driver as he backs the collection vehicle up to the container, attach the container to the loading mechanism on the back of the packer, activate the dumping mechanism and then return the container to its original location. There are a number of restaurants and other commercial establishments which require six-day-per-week refuse collection because of the putrescible refuse they discard (primarily fish). For this reason Port Orange must provide six-day-per-week service to these customers.

Based on a preliminary review and discussions with POG&TD supervisory personnel six-day commercial collection is a necessity. The use of a two-person crew is also required for three reasons.(1) First, without the walker the driver would have a difficult time backing up to each container in an efficient manner. Second, the walker is required to operate the dumping mechanism. If the driver had to operate the dumping mechanism considerable time would be lost and the daily task would exceed 8 hours (The present average task time is 6.2 hours). Third, in order to provide a safe working environment it is not recommended to use one person to collect the containers. This is because in the event of an accident the second person will be able to offer invaluable assistance immediately, whereas if a person was operating the loading mechanism alone and an accident occured it could be hours before he was noticed. Therefore, the system as presently manned and operated is considered to be an efficient and practical method for collection and does not appear to have areas for obvious improvement at this time.

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(1) While not economically justifiable to replace the new rear-loader collection vehicle at this time, POG&TD personnel should investigate the possibility of utilizing a front-loader vehicle when equipment replacement becomes necessary. A front-loader vehicle could be driven and operated in a safe and efficient manner by one person and thereby possibly reduce the operating costs for commercial collection.

CHAPTER 3

METHODS FOR INCREASING RESIDENTIAL SOLID WASTE COLLECTION SYSTEM PERFORMANCE

CHAPTER 3

METHODS FOR INCREASING RESIDENTIAL SOLID WASTE COLLECTION SYSTEM PERFORMANCE

The objective of this section is to investigate methods which can be used to increase the productivity and cost efficiency of refuse collection in Port Orange.

A preliminary investigation was made of the potential for improving the POCS performance in the following areas:

- Level of service
- Crew size
- Schedule
- Routing
- Equipment usage
- Lawn clipping segregation
- Solid waste transfer

LEVEL OF SERVICE

An obvious way to obtain significant cost savings within the POCS is to reduce the level of service. This would involve a change in the basic level of service from twice-per-week collection to once-per-week collection.

The reduction in level of service from twice-per-week to once-per-week collection has a very good potential for providing a cost reduction for the POCS. It is a general rule (which works well in most cases) that a labor force reduction of 33% can be made if the switch is made from twice-per-week to once-per-week collection. Since the POCS uses four crews, this would probably mean an elimination of one crew and a resulting cost savings of about $67,000/yr.

One problem which could occur with a change in collection frequency is that a health hazard might be created. Standing household refuse provides a good environment for the breeding of insects (e.g., houseflies) and other disease spreading pests. The potential for this problem is partially dependent upon the climate. In some hot and humid climates household refuse is disposed of more than once per week to prevent a fly problem rather than to provide more convenient service. Considering the climate of Port Orange it is likely that once-per-week collection would have public health impacts. Based on the possible adverse public health conditions, it is concluded that changing to once-per-week collection would probably not be suitable for Port Orange.

CREW SIZE CHANGES

There are two possible changes in the size of the POCS crews which could affect the productivity and cost effectiveness of the system:

- A reduction in the crew size from three-person to two- or one-person crews.
- An increase in the crew size from three-person to four-person crews.

In Chapter 2, a comparison between the POCS and other highly productive collection systems was made. Two of the collection systems used crew sizes smaller than the POCS crews. The one-person crew had a higher per-crewperson productivity but a lower per-walker and per-crew productivity and the subsequent per-home collection cost was approximately 31% greater (remember that the estimated costs were based on Port Orange labor and equipment costs). The two-person crew had a higher per-walker productivity and similar per-crewperson productivity but an overall lower per-crew productivity. The resulting per-home collection cost was also 15% greater than that of Port Orange.

These estimates were based on calculated average productive times for the POCS crews, and for these crew size changes to be instituted at Port Orange, either more crews or increased task times would be required. The only way to save additional costs over those previously presented would be to have the same number of crews handling the same routes. This would result in increased task time requirements for each

crew because of the net per-crew reduction in productivity. Assuming the per-crew productivities of the comparsion systems in Chapter 2 are applicable, the average total daily task time for one- and two-person crews on the POCS routes are shown in Table 3.1. It is evident that the total task time required is in excess of 8 hours. For a task-incentive program to succeed it must be possible for the employees to obtain a reward for working productively (i.e., 8 hours pay for less than 8 hours work). The change to smaller crews therefore, does not appear to be beneficial because not only would it involve excess overtime but it would most probably reduce productivity because of the lack of rewards for working productively.

Increasing crew sizes from three-person to four-person crews would likely increase the productivity of the individual POCS crews. While productivity may increase, in many cases, it has been found that four-person crews are uneconomical to operate when compared with three-person crews. This normally stems from the fact that the third walker (fourth person on the crew) is not fully utilized and/or slows down the other walkers by crowding the working area behind the packer. This normally reduces the net productivity of the entire crew to a point where the per-pickup cost of collection with four-person crews is higher than the cost with a three-person crew. For this reason four-person crews are not recommended and were not evaluated further.

Based on the probability that the addition or reduction of the crew's size would result in overcrowded working space or in excessive task time for the POCS crews, it is concluded that the crew size changes will not improve POCS performance.

SCHEDULE CHANGES

The schedule changes evaluated here refer to a change in the existing garbage and trash collection schedules. The alternative would involve collecting the trash on the same day as the garbage is collected. The POCS work week would then be shortened from five days per week to four days per week. From a technical point of view, this plan appears to be feasible. There should be no problem combining the materials since, at present, the same packer vehicles are used to

TABLE 3.1

TASK TIME FOR REDUCED CREW SIZES IN PORT ORANGE

CREW SIZE	PRODUCTIVITY PICK-UPS/ON-ROUTE CREW-HR [1]	PICK-UPS/DAY REQUIRED [2]	REQUIRED PRODUCTIVE TIME (HRS/DAY) [3]	AVERAGE NON PRODUCTIVE TIME (HRS/DAY) [4]	TOTAL REQUIRED TASK TIME [5]
1	84	950	11.3	1.8	13.1 HRS/DAY
2	138	950	6.7	1.8	8.7 HRS/DAY

(1) See Table 2.6.

(2) From Port Orange Route Survey.

(3) Pick-ups/day - Productivity per crew.

(4) From Port Orange Productivity Survey.

(5) Productive & non-productive time.

haul both trash and garbage and they are both dumped at the county landfill.

Table 3.2 shows the task time estimates for the present separate garbage and trash collection system and the alternative plan utilizing combined garbage and trash collection. Based on the six-week data collection survey described in Chapter 2, each POCS crew works approximately 6.4 hours per day on garbage collection (Monday, Tuesday, Thursday and Friday) and 6.2 hours per day on trash collection (Wednesday).

While labor costs will remain unchanged for the POCS (Employees will be paid for four, ten-hour days per week rather than five, eight-hour days per week) the operating and maintenance costs for the collection equipment will be reduced. This is primarily due to the fact that each route will be travelled only twice per week rather than the three times per week under the existing schedule. As fuel and oil costs continue to increase, this savings in overall weekly travel distance will help to stem the increase in future collection costs and will undoubtably reduce present system operation costs.

It is believed that the use of a four-day work week is a desirable alternative that represents a logical approach to reducing the collection costs for the city of Port Orange. It is also quite likely that simultaneous garbage and trash collection will be more efficient than separate collection. This could also provide the system with additional growth capacity through increasing route sizes as the City grows and still maintain the high productivity that a task-incentive program provides.

ROUTING CHANGES

It is believed that the performance of the POCS can be enhanced by an improved routing system. At present the POCS has no specific paths of travel on each route and therefore the possibility exists that the crews do a considerable amount of backtracking during a day's collection. The city is also experiencing a rapid growth rate and consequently the areas of responsibility for the POCS crews are increased frequently.

Macro-Routing

The average task time for each route computed from the POCS survey is presented in Table 3.3. As can be seen from these data,

TABLE 3.2

ESTIMATED TASK TIMES FOR SYSTEM ALTERNATIVE

PRESENT SYSTEM	AVERAGE PER CREW HOURS/DAY	TASK TIME (1) HOURS/WEEK
GARBAGE DAYS (2)	6.4	25.6
TRASH DAY (3)	6.2	6.2
TOTAL		31.8
ALTERNATIVE		
GARBAGE AND TRASH DAYS	6.4 - 8.0	36.8 - 32.0

(1) Estimated POCS average.

(2) 4 days per week.

(3) 1 day per week.

TABLE 3.3

AVERAGE TASK TIME, PER-ROUTE BASIS

ROUTE	AVERAGE TASK TIME (HOURS/DAY)(1)
1	6.0
2	5.2
3	6.1
4	5.6
5	6.8
6	7.4
7	6.8
8	6.7

(1) This does not include trash collection.

routes 1, 2, 3, and 4 generally take less time to complete than do routes 5, 6, 7 and 8. A more important measurement in a task-incentive program is the actual weekly task hours per crew. Table 3.4 illustrates this information. The average weekly task time (excluding trash collection) is 25.3 hrs/wk. The maximum deviation from the average is 5%, therefore, it can be concluded that the existing macro-routing or basic division of the city into areas of responsibility is well balanced among the crews.

The subsequent addition of pick-up locations to a specific route should be done with regard to the total task time involved per route. POG&TD personnel will need to review the areas of responsibility on a regular basis to ensure that the division remains equitable. As housing units are added on the outskirts of town, it may be necessary to increase the areas with no growth and restructure the growing areas accordingly. As the city continues to grow and the areas of responsibility grow, the daily and weekly task times will also increase. As the task time increases, the benefits realized by the workers for working on a task-incentive program will deteriorate. When this begins to happen the productivity of the system will drop. Generally, the crews productivity will begin to decrease and eventually the city will find itself paying for overtime benefits. At this point the POG&TD personnel will need to reassess the division of the city and may have to add an additional crew.

It is important that the POG&TD personnel add additional units to routes in an equitable manner and monitor total task times and productivities to determine when system adjustments are necessary.

Micro-Routing

The specific areas of responsibility (or macro-routes) are currently not laid out in specific micro-routes or paths of travel. The use of a specific path for collection vehicles to follow can improve both the productivity and reduce the on-route time and mileage. This section presents a breakdown of the 8 areas of the city (macro-routes) and specific paths of travel, or micro-routes, to follow.

The heuristic method of micro-routing was used to determine the collection vehicle paths for each of the areas. The heuristic approach

TABLE 3.4

AVERAGE WEEKLY TASK TIME

CREW	ROUTE	WEEKLY TASK TIME (HOURS)(1)
A	1,8	25.4
B	2,7	24.0
C	3,5	25.8
D	4,6	26.0

(1) This does not include trash collection.

utilized to determine the paths of travel on each macroroute involves the application of various patterns for routes in a trial and error method to minimize non-productive and time consuming travel. Figures 3.1 through 3.8 show the micro-routes developed for each POCS crew to follow within its collection area or macro-route. These paths allow for collection of all the residences on each route with a one-pass methodology. Dead travel, left-hand turns, and backtracking were minimized as much as possible within each area. The micro-routes are all continuous and show no breaks for off-route lunch or landfill trips. When the collection vehicle leaves the route the collection should be resumed at the point that it was discontinued. It is believed that these micro-routes can provide an increase in the efficiency of performance for the POCS.

Care should be taken when adding additional units to a micro-route to ensure that the route is adjusted to include the new pick-ups with a minimum of additional dead travel, left-hand turns and backtracking. An excellent reference and a valuable tool in applying the heuristic method is "Heuristic Routing For Solid Waste Collection Vehicles" EPA publication SW-113, 1974. It is recommended that this reference be referred to when adjustments to the micro-routes become necessary.

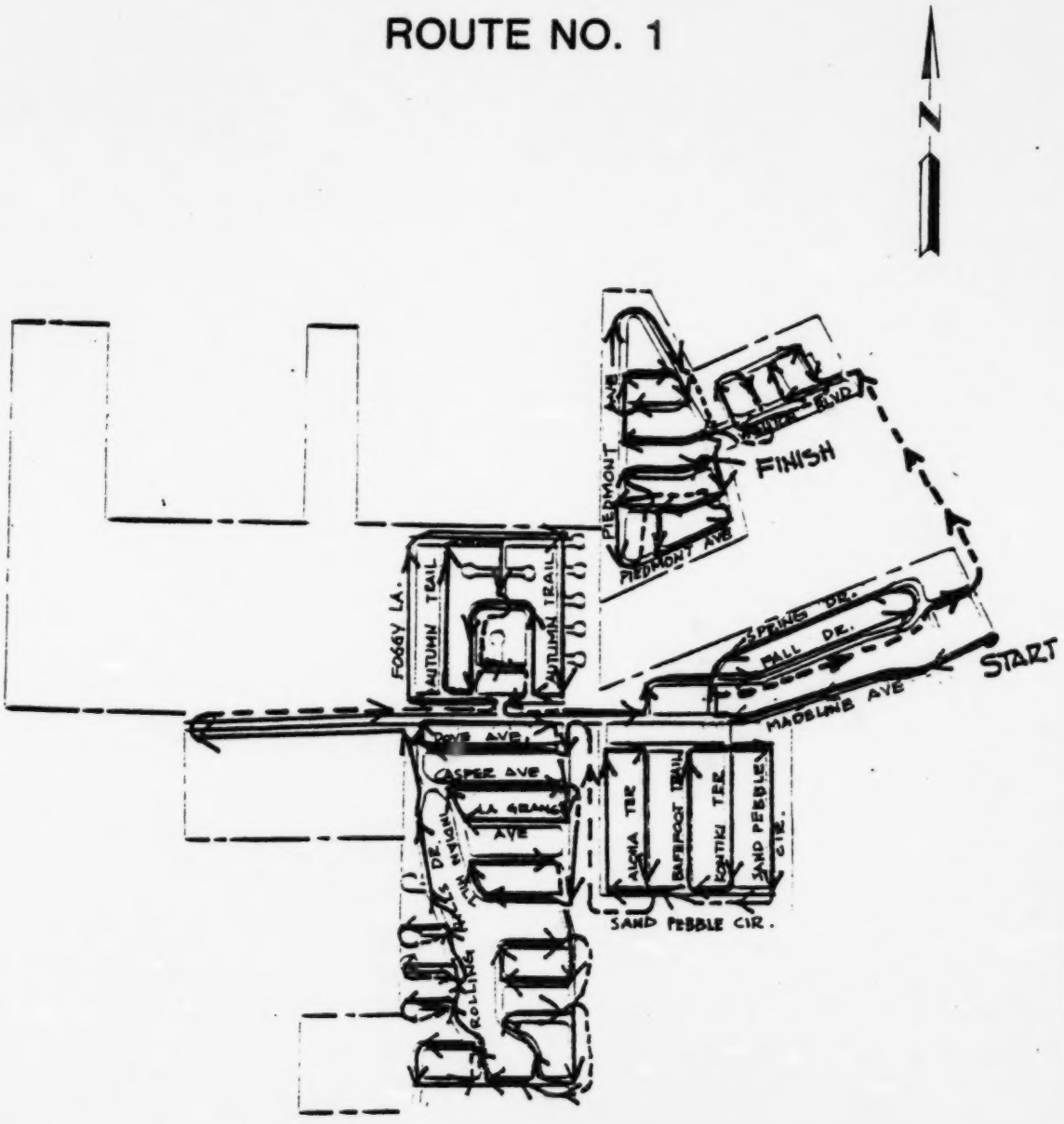
COST SAVINGS THROUGH EFFECTIVE EQUIPMENT USAGE RADIOS

The POG&TD's recent purchase of four new collection vehicles should reduce the excessive maintenance problem the city has experienced over the past few years. In the future, the POG&TD should keep detailed operation and maintenance records for each vehicle to aid in determining when the vehicles should be replaced. It has been estimated that the optimum replacement period for motor-vehicle equipment is between five and seven years.(1) This is, of course, dependent on a combination of several factors. When the actual cost of operating and maintaining a vehicle plus the depreciated capital cost and down-time costs become greater than the costs of purchasing and operating a new vehicle, the old vehicle should be replaced. It is recommended that POG&TD personnel compare actual operating costs on a regular basis

(1) Wilson D.G. "Handbook of Solid Waste Management, Van-Nostrand Reinhold Co., New York, 1977.

FIGURE 3.1

ROUTE NO. 1

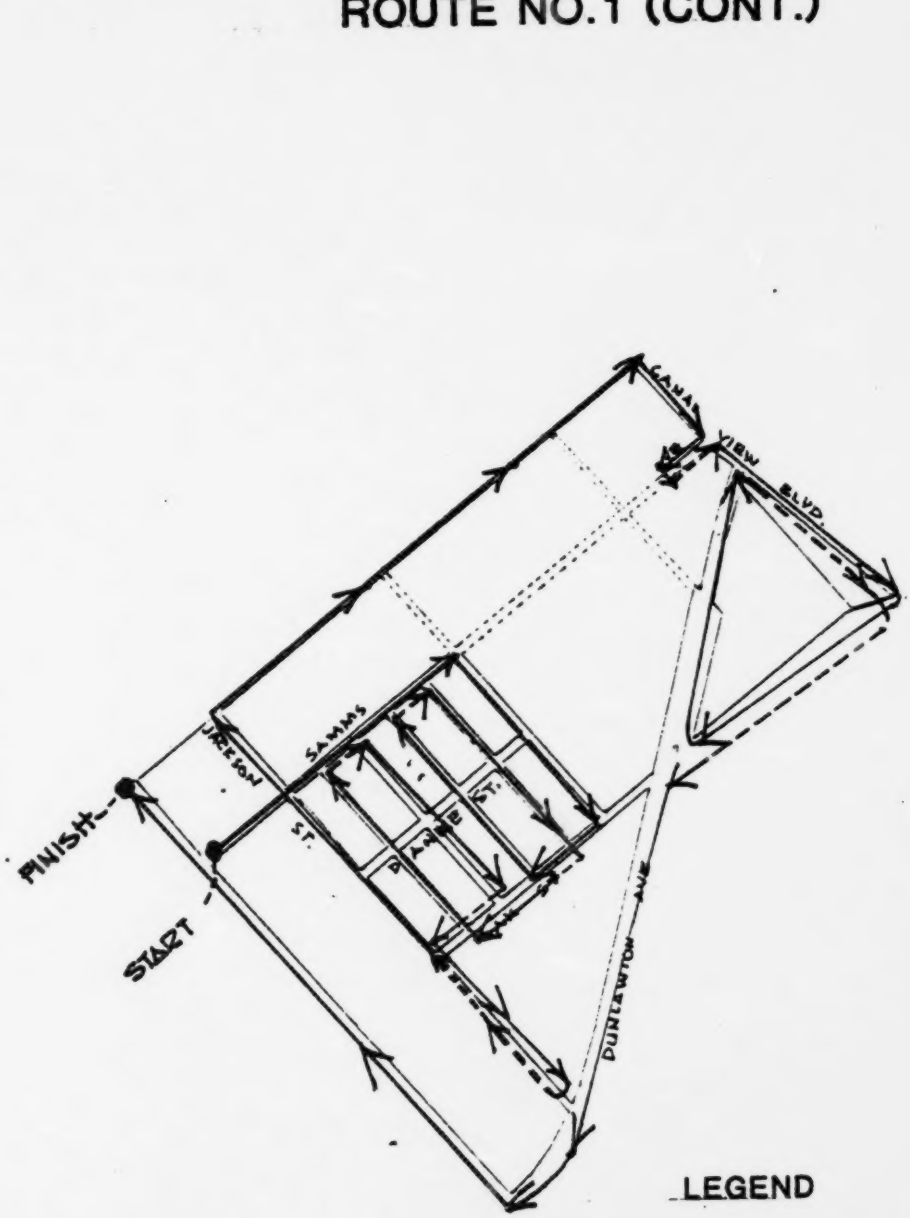


LEGEND

—— Collection Segments

--- Non-Collection Segments

ROUTE NO.1 (CONT.)



LEGEND

——— Collection Segments

– – – Non-Collection Segments

FIGURE 3.2

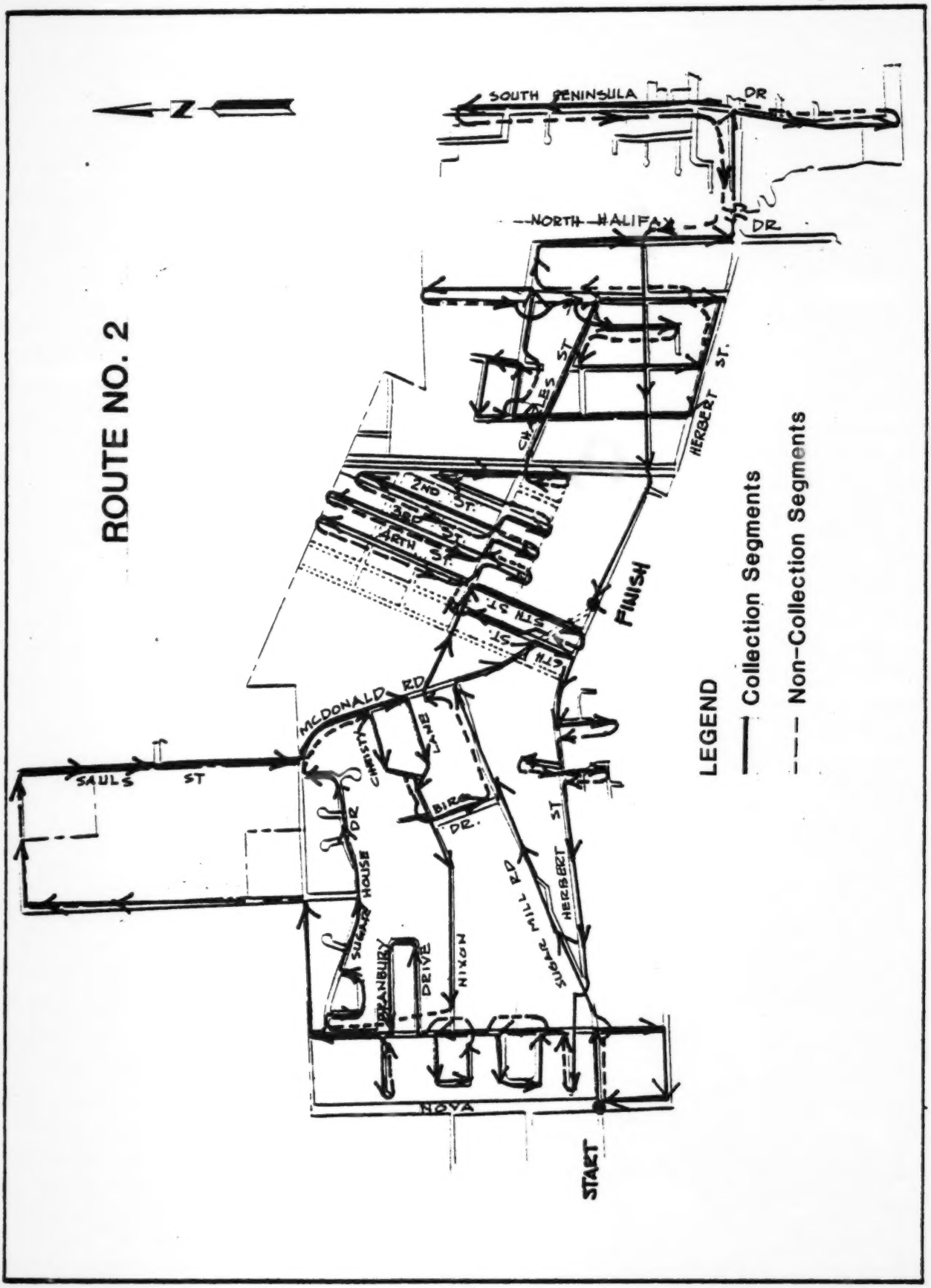
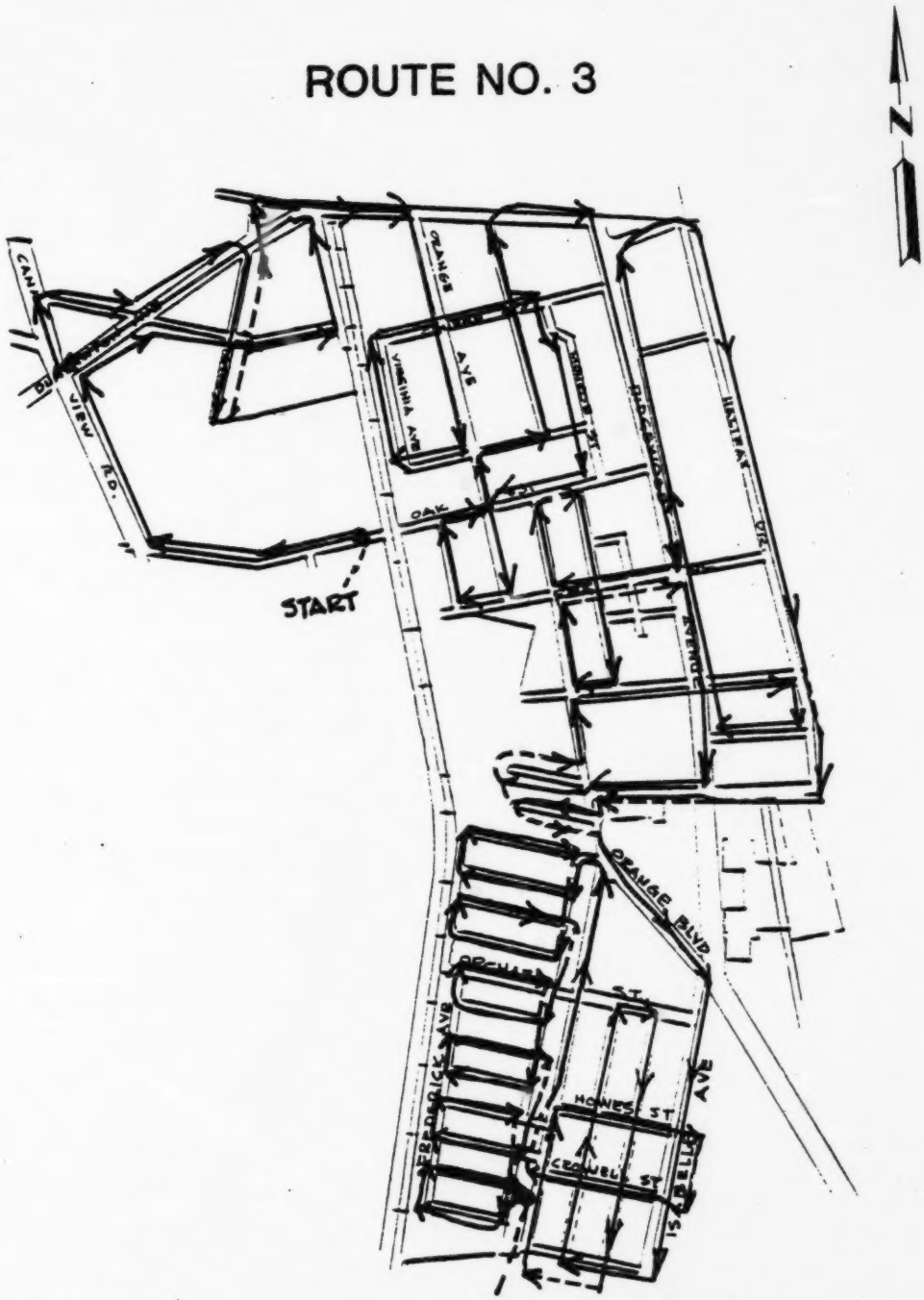

ROUTE NO. 2
N
SOUTH PENINSULA DR
NORTH HALIFAX DR
SAULS ST
MCDONALD RD
CHRISTY LANE
BIRCH DR.
SUGAR HOUSE DR
CRANBURY DRIVE
NIXON
SUGAR MILL RD
HERBERT ST
NOVA
START
FINISH
LEGEND
Collection Segments
Non-Collection Segments

FIGURE 3.3

ROUTE NO. 3



LEGEND

— Collection Segments

- - - Non-Collection Segments

FIGURE 3.4

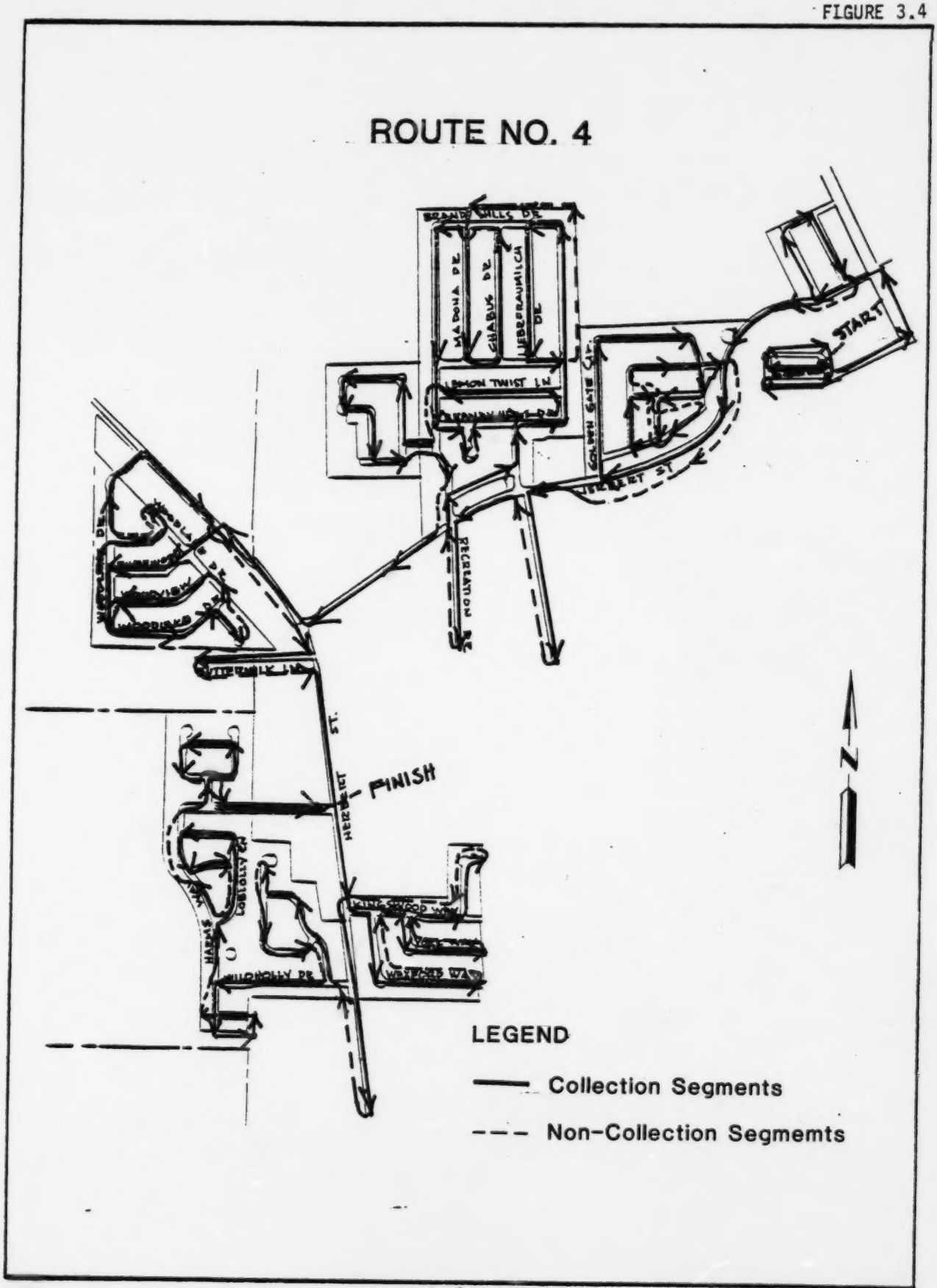


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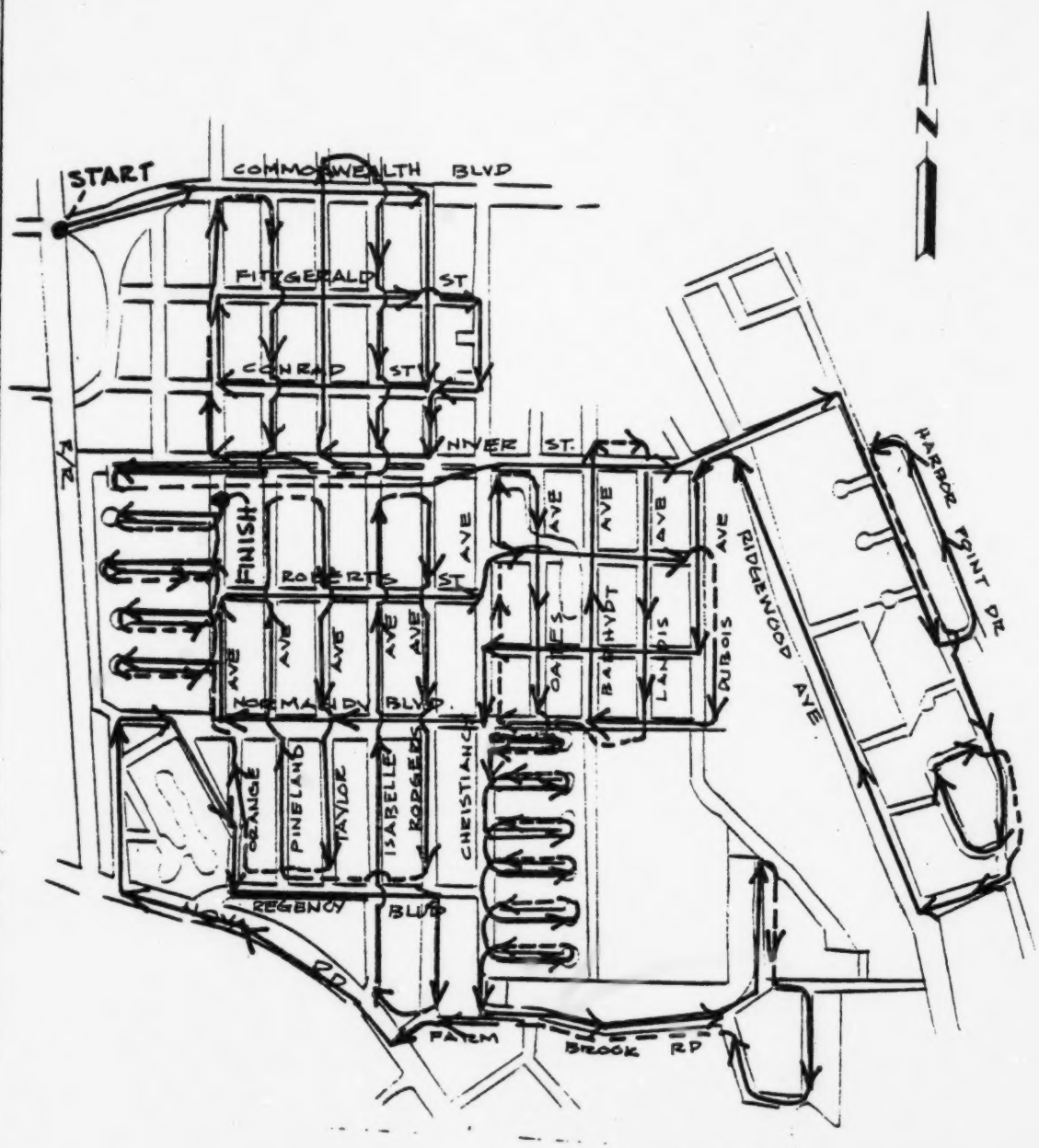
FIGURE 3.5

ROUTE NO. 5

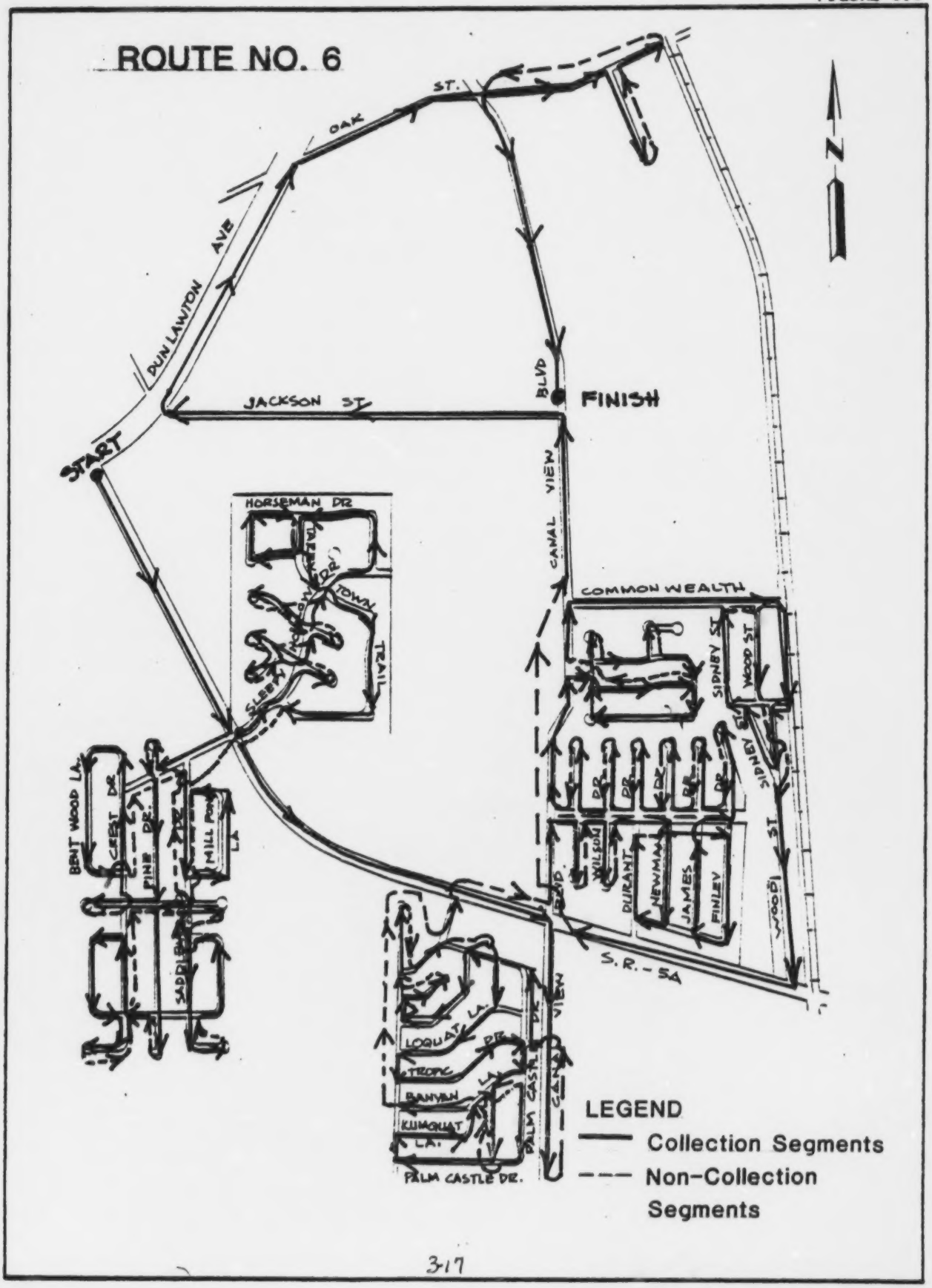


LEGEND

——Collection Segments

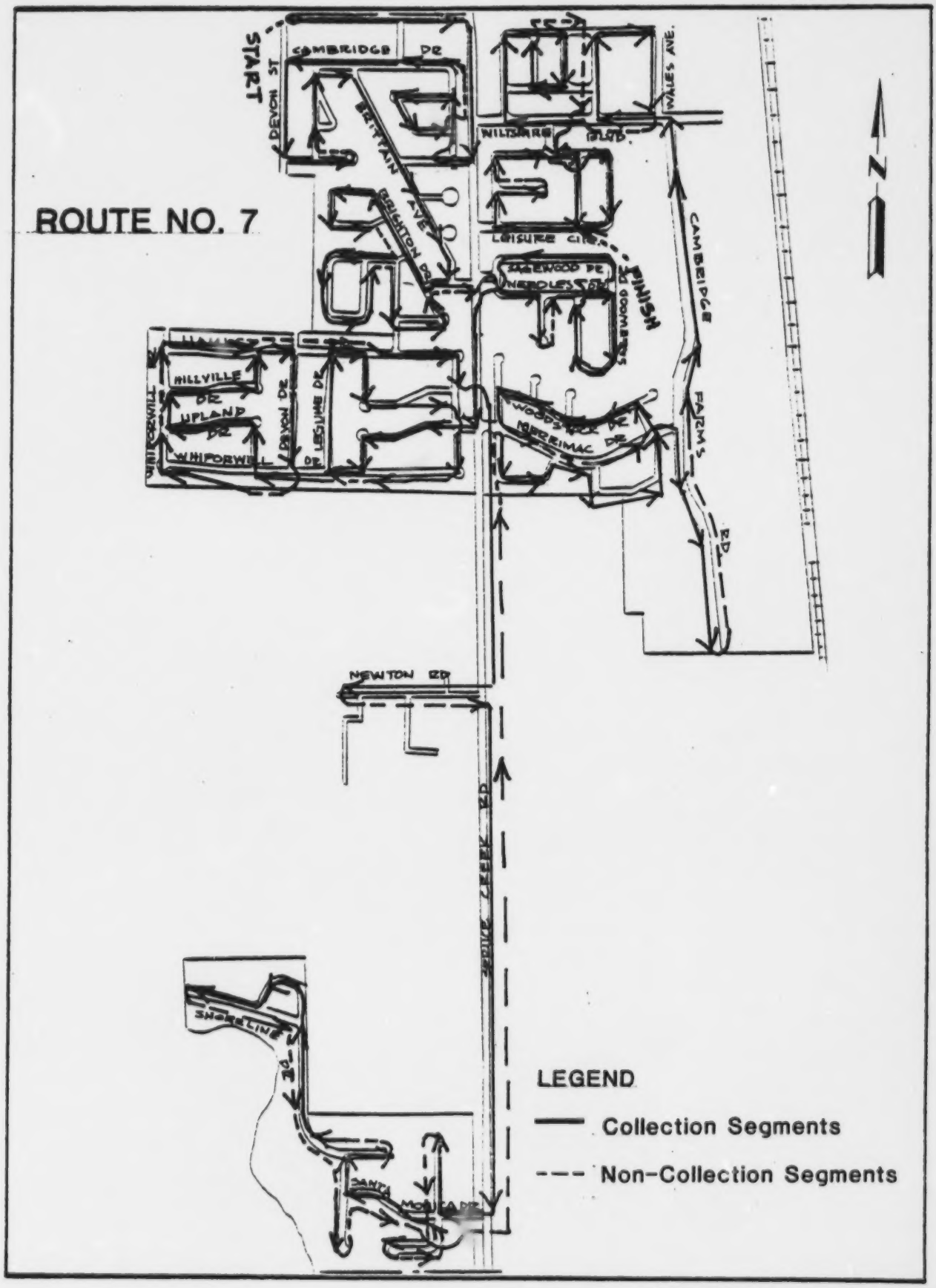
---Non-Collection Segments

FIGURE 3.6



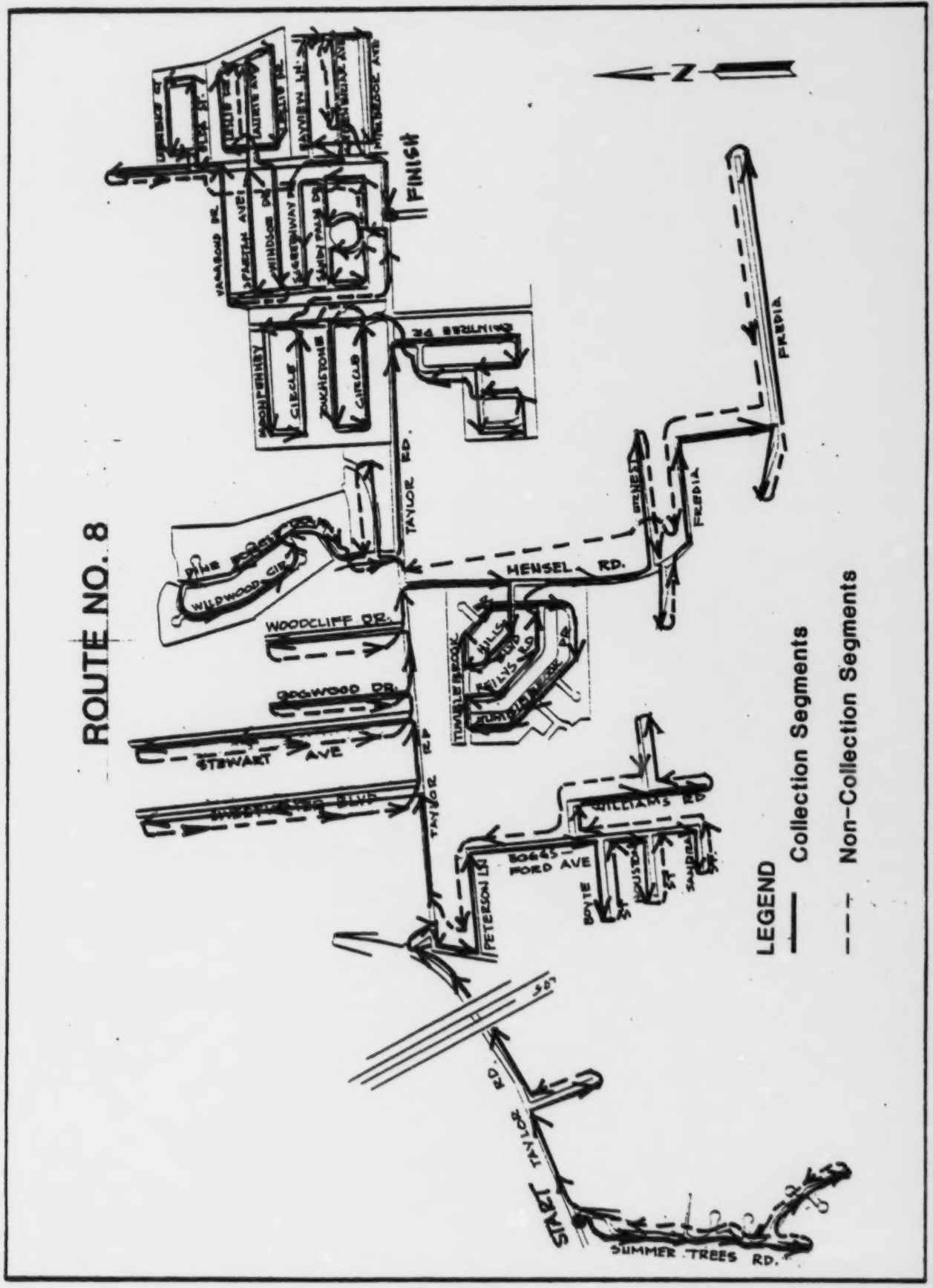
ENGINEERING-SCIENCE, INC.

FIGURE 3.7



ENGINEERING-SCIENCE, INC.

FIGURE 3.8


ROUTE NO. 8
FINISH
START
N
TAYLOR RD.
HENSEL RD.
WOODCLIFF DR.
STEWART AVE
WILLIAMS RD
SUMMER TREES RD.
PREDIA
ERNEST
WILDWOOD CIR
LEGEND
Collection Segments
Non-Collection Segments

with the projected costs of owning and operating new vehicles to determine the most efficient vehicle replacement period.

As the need to replace vehicles becomes evident, the use of alternative equipment types should be evaluated. The following discussion (Method of Cost Reduction and Cost Analysis) is an example of how the impact of alternative equipment could be evaluated. This alternative equipment evaluation is based on the existing system parameters but can be easily changed to reflect system parameters at a later date when equipment replacement is warranted.

The present POG&TD equipment inventory was discussed in Chapter 2. The system currently uses the rear-load packer collection vehicle with conventional compacting mechanisms and a 20-cubic yard capacity.

Method of Cost Reduction

Landfill trips cost money in terms of equipment and labor costs. If the total number of required landfill trips for a given collection system can be reduced, there will be a savings in equipment operation maintenance costs, and collection workers will be able to spend more time on productive activity (on-route collection). In the case of a task-incentive program, a reduction in landfill trips means that the collection workers can spend a higher percentage of their time on-route and can make more pick-ups per day while working the same total number of hours. Thus, the per crew daily productivity is increased and it is possible to perform the necessary number of collections with fewer crews and vehicles. This should mean a reduction in total collection system costs.

Cost Analysis

A comparison was made to determine the impact that the use of 30-cubic yard packer vehicles could have on the POCS performance. For illustrative purposes, the existing POCS using four crews to perform four day-per-week collection of garbage with the present equipment inventory will be referred to as System A. For comparison purposes, a hypothetical system will be created; System B. All operating parameters for System B will be the same as System A except:

- System B will use 30-cubic yard packer vehicles exclusively and;
- System B will operate with fewer crews.

Table 3.5 shows an estimate of the system-wide average number of crew-hours that would be spent weekly on landfill trips with System A. The number of landfill trips shown in Table 3.5 is based on the POCS survey which was discussed in Chapter 2. These estimates are for garbage collection only. Given the number of landfill trips, the time required to make these trips on a daily basis was calculated assuming that, on a system-wide average basis, each trip requires about 45 minutes (the estimate of per-trip time was derived from the data sheets provided by POCS personnel, see Table 2.3). Based on these data, it is estimated that a total of 24 crew-hours (72 man-hours) would be spent weekly on landfill trips with System A.

Since System B uses 30-cubic yard packer vehicles exclusively, the per-crew time spent on landfill trips will be less than System A. Based on the considerations discussed in the previous paragraph, it is estimated that the POCS average time for landfill trips with System B is about 4.0 hours per crew per week (see Table 3.5).

Table 3.6 shows a breakdown of weekly time utilization for Systems A and B. As previously stated, System A uses four crews; each spending an average of 6.4 hours/day on garbage collection tasks (a total of 103 crew-hours/week). However, System B has been set up to use three crews; one less than System A. As with System A, each System B crew spends a total of 6.4 hours/day working, although, because of the reduced amount of time spent on landfill trips (due to increased capacity packer vehicles), System B provides a greater amount of productive time per crew on-route than System A (62 crew-hours/week). Each crew in System B can then collect from more units per day then can each crew in System A. This increased productivity, though, would not be useful unless the three crews could service the entire city. Table 3.6 summarizes the characteristics of each system. The required productivity for System B to be able to service the entire city is 234 pick-ups/crew-hour on-route. The only way an increase of this magnitude would be possible would be through an increase in crew size. For cost comparison purposes, it is assumed that System B will therefore, utilize one, three-person crew with a productivity of 206 pick-ups/crew-hr

TABLE 3.5

ESTIMATE OF TIME SPENT ON LANDFILL TRIPS

Packer Vehicle Type	No. in Service	Avg. No. Landfill Trips Per Week Per Vehicle	Time Spent on Landfill Trips[1] (Crew-Hours/Week)	
			Per Vehicle	All Vehicles
System A				
20-Cubic Yard Rear Load	4	8.0	6	24
System B				
30-Cubic Yard Rear Load	3	5.3	4	12

(1) Estimated assuming system wide-average of 45 min/trip.

TABLE 3.6

ALTERNATIVE SYSTEMS TASK TIME BREAKDOWN

SYSTEM A (USING PRESENT EQUIPMENT INVENTORY)

NO. OF CREWS	4
TOTAL TASK TIME (1)	102 CREW-HR/WK
TIME SPENT ON:	
DRIVING TO ROUTE (2)	4.5 CREW-HR/WK
LANDFILL TRIPS (3)	24 CREW-HR/WK
PRODUCTIVE (ON-ROUTE) TIME	73.5 CREW-HR/WK
REQUIRED PRODUCTIVITY (4)	206 PICK-UPS/CREW-HR ON-ROUTE

SYSTEM B (USING 30-CUBIC YARD PACKERS)

NO. OF CREWS	3
TOTAL TASK TIME (1)	77 CREW-HR/WK
TIME SPENT ON:	
DRIVING TO ROUTE (2)	3.4 CREW-HR/WK
LANDFILL TRIPS (3)	12 CREW-HR/WK
PRODUCTIVE (ON-ROUTE) TIME	65 CREW-HR/WK
REQUIRED PRODUCTIVITY (4)	234 PICK-UPS/CREW-HR. ON ROUTE

(1) Assume system-wide average of 6.4 hr/crew-day.

(2) Estimate system-wide average of 0.3 hr/crew-day.

(3) See Table 3.1 for estimate.

(4) Based on 7593 Homes served with 2 pick-ups per week.

(as the POCS crews are now) and two, four-person crews with conservative productivities of 250 pick-ups/crew-hr. Cost estimates have been done to illustrate the cost savings that could occur.

Life-cycle cost estimates for the types of vehicles being considered are shown in Appendix A. Tables 3.7 and 3.8 show the estimates of total costs for Systems A and B, respectively. The results of the cost estimates are as follows:

System	Estimated Total Annual Cost (1980$/year)
A	$ 217,300
B	$ 207,028

While it is not reasonable to replace recently purchased vehicles at this time, alternative equipment usage should be investigated when the new equipment needs replacing. At that time a cost estimate should be performed similar to the one in the previous example to determine the optimum equipment type for the POCS.

In summary, POG&TD personnel should keep detailed records of operation and maintenance costs for the collection vehicles to assist in determining the optimum equipment replacement period. When the replacement of the new POCS packers becomes apparent, alternative equipment usage should be investigated to ensure optimization of system costs.

It is also strongly recommended that the POG&TD consider adding two-way radios for direct on-route communication with all the collection vehicles for the following reasons:

- Radios will reduce unnecessary backtracking for special pick-ups and areas missed on the route.
- Radios will provide immediate time saving response in the event of a breakdown.
- Radios will provide increased control over the system by allowing location identification of the vehicles at any time.
- Radios will provide an additional safety provision by allowing immediate response in the event of an accident or injury.

TABLE 3.7

ANNUAL COST ESTIMATE-RESIDENTIAL COLLECTION ONLY

SYSTEM USING PRESENT EQUIPMENT INVENTORY (SYSTEM A)

LABOR (4 CREWS)	
4.88 DRIVERS @ $4.81/hr	$ 48,828
9.76 WALKERS @ $4.24/hr	86,060
PERSONNEL WAGES	134,888
PERSONNEL OVERHEAD (16%)	21,580
TOTAL WAGES	156,468
FRINGE BENEFITS (26%)	40,682
TOTAL LABOR COST	$ 197,150
EQUIPMENT (1)	
20-CUBIC YARD REAR LOADER - LOADMASTER (3 @ 17.810/yr)	53,430
20-CUBIC YARD REAR LOADER - HEIL	21,050
TOTAL EQUIPMENT COST	74,480
TOTAL ANNUAL COST (2)	$271,630
TOTAL ANNUAL COST (GARBAGE COLLECTION ONLY)(3)	$217,300
UNIT COST	$ 28.6/home-year

(1) See Appendix A For Life Cycle Cost Estimates

(2) Garbage And Trash Collection

(3) All Costs are 1980 $

TABLE 3.8

ANNUAL COST ESTIMATE - SYSTEM USING ONLY

30-CUBIC YARD PACKERS (SYSTEM B) - (RESIDENTIAL COLLECTION ONLY

LABOR (3 CREWS)	
(1) 3.88 DRIVERS @ $4.81/hr	$ 38,820
(2) 9.76 WALKERS @ $4.24/hr	86,060
PERSONNEL WAGES	124,880
PERSONNEL OVERHEAD (16%)	19,981
TOTAL WAGES	144,861
FRINGE BENEFITS (26%)	37,664
TOTAL LABOR COST	$ 182,525
EQUIPMENT (3)	
30-CUBIC YARD REAR LOADERS	
(3 @ $25,420/yr)	76,260
TOTAL EQUIPMENT COST	76,260
TOTAL ANNUAL COST (4)	$ 258,785
TOTAL ANNUAL COST (GARBAGE COLLECTION ONLY)(5)	$ 207,028
UNIT COST	$ 27.3/home-year

(1) Assume 3 drivers + 88% of 1 standby driver.

(2) Assume 8 3walkers + 88% of 2 standby walker.

(3) See Appendix A for vehicle life cycle costs.

(4) Garbage and trash collection.

(5) All costs are 1980$.

SEGREGATION OF LAWN CLIPPINGS

Until September 1980, the City of Port Orange operated an incinerator for solid waste disposal. The large percentage of lawn clipping in the city's waste (estimated to be as high as 30% by volume) caused problems in the incineration of the solid waste. The lawn clippings are wet and would clump together in the incinerator. The clumps would be charred on the outside but the inside would not be burned, therefore, there was little reduction in volume. Since the incinerators have been shut down, this no longer presents a problem.

The possibility of composting the lawn clippings and selling the compost was addressed. The City of Port Orange management personnel stated that there was no market for compost in the area and the compost would have to be hauled away anyway. In general, composting of yard wastes has not been economical unless the product can be sold. Therefore, the segregation of lawn clippings and yard wastes for composting is not recommended.

SOLID WASTE TRANSFER

The potential for cost saving through the use of a solid waste transfer system was evaluated. Solid waste transfer systems (combination of transfer facility and transfer vehicle) are often used to reduce the costs of hauling refuse. With a transfer station refuse collection vehicles transport the solid waste to a central facility where it is unloaded either directly or indirectly onto a transfer vehicle that will carry it to the ultimate disposal site. Transfer vehicles can usually transport solid waste at a lower per ton cost than refuse collection vehicles. A solid waste transfer operation becomes economically attractive when the costs of the transfer station plus the costs to transport the waste to the disposal site with a transfer vehicle are less than the costs to transport the refuse directly from the route with the collection vehicles. The possible use of the solid waste transfer concept in the City of Port Orange is especially attractive because of the availability of the existing incinerator as a transfer station.

Refuse haul costs and transfer facility operation costs were estimated for Port Orange by a local consultant in a report dated December 12, 1979.(2)

These costs were updated assuming 1% per month inflation to the middle of the 1981 Port Orange fiscal year (April 1981). Using these numbers, it is estimated that the total cost for converting the incinerator to a transfer station is $11.31/ton of waste hauled. The estimated cost for using the packers for direct haul from the route is $9.82/ton (see Appendix A for calculation).

It is therefore recommended that the incinerator not be used as a transfer station and that the packers continue to haul refuse directly to the county landfill.

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(2)Briley, Wild & Associates, Inc., "Solid Waste Disposal Study, City of Port Orange", Ormond Beach, Florida, December 1979.

APPENDIX A

COST CALCULATIONS

TABLE A-1

LABOR COST ESTIMATE (1)

CITY OF PORT ORANGE

	WEEKLY	ANNUALLY
1.22 DRIVERS @ $4.81/hr	$187.78	$ 9,764.56
2.44 WALKERS @ $4.24/hr	331.06	17,215.12
PERSONNEL WAGES	518.84	26,979.68
PERSONNEL OVERHEAD (16%)	83.00	4,316.00
TOTAL WAGES	601.84	31,295.68
FRINGE BENEFIT (26%)	156.48	8,136.95
TOTAL LABOR COST (2)	$758.32	$39,432.63

COMPARISON SYSTEM I

1.22 DRIVERS @ $4.81/hr	$187.78	$ 9,764.56
PERSONNEL WAGES	187.78	9,764.56
PERSONNEL OVERHEAD (16%)	30.05	1,562.60
TOTAL WAGES	217.83	11,327.16
FRINGE BENEFITS (26%)	56.63	2,944.76
TOTAL LABOR COST (2)	$ 274.47	$14,271.92

(1) Per crew cost, based on fiscal 1981 POG&TD average wage rates.

(2) Cost for garbage collection only. Does not include Wednesday trash pick-up, landfill disposal or commercial collection.

TABLE A -1 (CONT)

LABOR COST ESTIMATE (1)

COMPARISON SYSTEM II

	WEEKLY	ANNUALLY
1.22 DRIVERS @ $4.81/hr	$ 187.78	$ 9,764.56
1.22 WALKERS @ $4.24/hr	165.53	8,607.56
PERSONNEL WAGES	353.31	18,372.12
PERSONNEL OVERHEAD (16%)	56.53	2,939.54
TOTAL WAGES	409.62	21,311.66
FRINGE BENEFITS (26%)	106.50	5,538.00
TOTAL LABOR COST (2)	$ 516.12	$26,849.66

COMPARISON SYSTEM III

1.22 DRIVERS @ $4.81/hr	$ 187.78	$ 9,764.56
2.44 WALKERS @ $4.24/hr	331.06	17,215.12
PERSONNEL WAGES	518.84	26,979.68
PERSONNEL OVERHEAD (16%)	83.00	4,316.00
TOTAL WAGES	601.84	31,295.68
FRINGE BENEFITS (26%)	156.48	8,136.95
TOTAL LABOR COST (2)	$ 758.32	$39,432.63

(1) Per Crew costs, based on fiscal 1981 POG&TD average wage rates.

(2) Cost for garbage collection only. Does not include Wednesday trash pick-up, landfill disposal or commericial collection.

TABLE A-2

COLLECTION EQUIPMENT COSTS (1)

LIFE-CYCLE COST ESTIMATE FOR 20-cubic yard REAR LOAD PACKER VEHICLES ARE GIVEN IN TABLE A-4

AVERAGE ANNUAL COST = $ 17,810/yr

AVERAGE WEEKLY COST = $ $\frac{17,810}{52}$ = $ 343.00/wk

GARBAGE COLLECTION ONLY:

AVERAGE WEEKLY COST = $\frac{\$17,810 \times 4}{52 \times 5}$ = $274.00/wk

(1) APPLY TO ALL SYSTEMS.

TABLE A-3

RESIDENTIAL (GARBAGE & TRASH) COLLECTION SYSTEM COST ESTIMATE

LABOR [1]	WEEKLY	ANNUALLY
4.88[2] Drivers @ $4.81	$ 939	$ 48,828
9.76[3] Walkers @ $4.24	1,655	86,060
PERSONNEL WAGES	2,594	134,888
PERSONNEL OVERHEAD (16%)	415	21,580
TOTAL WAGES	3,009	156,468
FRINGE BENEFITS (26%)	782	40,682
TOTAL LABOR COST	$3,791	$197,150
PER CREW LABOR COST	948	49,288
EQUIPMENT[4]		
20-cubic yard REAR LOADER (1979 - Heil)	306	15,918
20-cubic yard REAR LOADER (1980 - Heil)	405	21,050
20-cubic yard REAR LOADER (1980 - LOADMASTER) 3 @ $17,810	1,028	53,430
TOTAL EQUIPMENT COST	$1,739	$ 90,398
TOTAL RESIDENTIAL EQUIPMENT COST [5]	1,339	69,539
PER CREW EQUIPMENT COST	335	17,384
TOTAL RESIDENTIAL COST	$5,130	$266,760

(1) Based on fiscal 1981 POCS average wage rates.
(2) 4 Drivers + 88% of 1-standby driver.
(3) 8 Walkers + 88% of 2-standby walkers.
(4) See Tables A-1, 2, 3 for vehicle life cycle costs.
(5) 77% of total equipment cost, residential; 23% commercial.

TABLE A-4

LIFE-CYCLE COSTS - 20-CUBIC YARD REAR LOADER (LOADMASTER)/
20-CUBIC YARD SIDE LOADER - 1980

	Year				
	1	2	3	4	5
Capital Investment and Depreciation:					
Trade-in value (% of delivery price)	75	55	40	30	25
Investment, start ($)	30,211	22,658	16,616	12,084	9,063
Year-end value ($)	22,658	16,616	12,084	9,063	7,553
Yearly capital cost ($)	7,553	6,042	4,532	3,021	1,510
Debt Service and Insurance:					
Average yearly worth ($) (1)	26,435	19,637	14,350	10,574	8,308
Yearly debt cost @ 12% ($)	3,172	2,356	1,722	1,269	997
Maintenance:					
Yearly estimate (% of delivery price)	4.5	6.5	10.5	16.5	22.5
Yearly estimated cost ($)	1,359	1,964	3,172	4,985	6,797
Fuel & Oil Cost ($)	5,000	5,000	5,000	5,000	5,000
Downtime:					
Availability factor (%)(3)	95	94	91	88	85
Hours not available (per year)	88	106	159	212	265
Cost @ $10/hr					
Reserve vehicle ($)	880	1,060	1,590	2,120	2,650
Productivity Loss due to Age(2)					
Productivity factor(3)	98	96	94	92	90
Extra hours required to match					
Production of new model	35	71	106	141	177
Cost @ $10/hr	350	710	1,060	1,410	1,770
Total Annual Cost ($)	18,314	17,132	17,076	17,805	18,724
Cumulative Vehicle Cost ($)	18,314	35,446	52,522	70,327	89,051

Average Annual Cost = $89,051/5 = $17,810/yr

(1) Average between worth at beginning of year and worth at end of year.
(2) Accounts for loss of productivity as equipment ages.
(3) Average for year based on 34 hrs/wk equipment operation.

TABLE A-5

LIFE-CYCLE COSTS - 20-CUBIC YARD REAR LOADER (HEIL-1980)

	Year				
	1	2	3	4	5
Capital Investment and Depreciation:					
Trade-in value (% of delivery price)	75	55	40	30	25
Investment, start ($)	39,910	29,933	21,951	15,964	11,973
Year-end value ($)	29,933	21,951	15,964	11,973	9,978
Yearly capital cost ($)	9,977	7,982	5,987	3,991	1,995
Debt Service and Insurance:					
Average yearly worth ($) (1)	34,922	25,942	18,958	13,969	10,976
Yearly debt cost @ 12% ($)	4,191	3,113	2,275	1,676	1,317
Maintenance:					
Yearly estimate (% of delivery price)	4.5	6.5	10.5	16.5	22.5
Yearly estimated cost ($)	1,796	2,594	4,191	6,585	8,980
Fuel & Oil Cost ($)	5,000	5,000	5,000	5,000	5,000
Downtime:					
Availability factor (%)(3)	95	94	91	88	85
Hours not available (per year)	88	106	159	212	265
Cost @ $10/hr					
Reserve vehicle ($)	880	1,060	1,590	2,120	2,650
Productivity Loss due to Age(2)					
Productivity factor(3)	98	96	94	92	90
Extra hours required to match					
Production of new model	35	71	106	141	177
Cost @ $10/hr ($)	350	710	1,060	1,410	1,770
Total Annual Cost ($)	22,194	20,459	20,103	20,782	21,712
Cumulative Vehicle Cost ($)	22,194	42,653	62,756	83,538	105,250

Average Annual Cost = $105,250/5 = $21,050/yr

(1) Average between worth at beginning of year and worth at end of year.
(2) Accounts for loss of productivity as equipment ages.
(3) Average for year based on 34 hrs/wk equipment operation.

TABLE A-6

LIFE-CYCLE COSTS - 20-CUBIC YARD REAR LOADER (HEIL-1979)

	Year				
	1	2	3	4	5
Capital Investment and Depreciation:					
Trade-in value (% of delivery price)	75	55	40	30	25
Investment, start ($)	37,181	27,886	20,450	14,872	11,154
Year-end value ($)	27,886	20,450	14,872	11,154	9,295
Yearly capital cost ($)	9,295	7,436	5,578	3,718	1,859
Debt Service and Insurance:					
Average yearly worth ($) (1)	32,534	24,168	17,661	13,013	10,225
Yearly debt cost @ 12% ($)	3,904	2,900	2,119	1,562	1,227
Maintenance:					
Yearly estimate (% of delivery price)	4.5	6.5	10.5	16.5	22.5
Yearly estimated cost ($)	1,673	2,417	3,904	6,135	8,366
Fuel & Oil Cost ($)	5,000	5,000	5,000	5,000	5,000
Downtime:					
Availability factor (%)(3)	95	94	91	88	85
Hours not available (per year)	88	106	159	212	265
Cost @ $10/hr					
Reserve vehicle ($)	880	1,060	1,590	2,120	2,650
Productivity Loss due to Age(2)					
Productivity factor(3)	98	96	94	92	90
Extra hours required to match					
Production of new model	35	71	106	141	177
Cost @ $10/hr	350	710	1,060	1,410	1,770
Total Annual Cost ($)	21,102	19,523	19,251	19,945	20,872
Cumulative Vehicle Cost ($)	21,102	40,625	59,876	79,821	100,693

Average Annual Cost = $100,693/5 = $20,139/yr(4)

(1) Average between worth at beginning of year and worth at end of year.
(2) Accounts for loss of productivity as equipment ages.
(3) Average for year based on 34 hrs/wk equipment operation.
(4) Exclude first year cost $79,591/4 = $19,898/year

TABLE A-7

LIFE-CYCLE COST - 30-CUBIC YARD REAR LOADER (ALTERNATIVE EQUIPMENT EXAMPLE)

	Year				
	1	2	3	4	5
Capital Investment and Depreciation:					
Trade-in value (% of delivery price)	75	55	40	30	25
Investment, start ($)	50,000	37,500	27,500	20,000	15,000
Year-end value ($)	37,500	27,500	20,000	15,000	12,500
Yearly capital cost ($)	12,500	10,000	7,500	5,000	2,500
Debt Service and Insurance:					
Average yearly worth ($) (1)	43,750	32,500	23,750	17,500	13,750
Yearly debt cost @ 12% ($)	5,250	3,900	2,850	2,100	1,650
Maintenance:					
Yearly estimate (% of delivery price)	4.5	6.5	10.5	16.5	22.5
Yearly estimated cost ($)	2,250	3,250	5,250	8,250	11,250
Fuel & Oil ($)	6,000	6,000	6,000	6,000	6,000
Downtime:					
Availability factor (%)(3)	95	94	91	88	85
Hours not available (per year)	88	106	159	212	265
Cost @ $10/hr					
Reserve vehicle ($)	880	1,060	1,590	2,120	2,650
Productivity Loss due to Age(2)					
Productivity factor(3)	98	96	94	92	90
Extra hours required to match					
Production of new model	35	71	106	141	177
Cost @ $10/hr	350	710	1,060	1,410	1,770
Total Annual Cost ($)	27,230	24,920	24,250	24,880	25,820
Cumulative Vehicle Cost ($)	27,230	52,150	76,400	101,280	127,100

Average Annual Cost = $ 127,100/5 = $25,420/yr

(1) Average between worth at beginning of year and worth at end of year.
(2) Accounts for loss of productivity as equipment ages.
(3) Average for year based on 34 hrs/wk equipment operation.
(4) Based on October 1980 cost of 30-cubic yard rear loader.

TABLE A-8

SOLID WASTE TRANSFER COSTS

UTILIZATION OF INCINERATOR AS A TRANSFER FACILITY

Estimated total cost annualized over ten years =
$9.77/ton (December 1979 dollars)(1)
Assuming 1% monthly inflation from 12/80 to the middle of the
1981 Port Orange fiscal year (10/80-10/81) - 4/1/81
or 1% per month x 16 months = 16%
or annualized transfer costs = $11.33/ton (1981 $)

DIRECT HAUL COSTS

Port Orange crews average opproximately 25% of their work day and 55% of the total mileage on landfill trips (from the data survey discussed in Chapter 2).

The average weekly labor cost for the POCS = $4,824

The average weekly equipment cost for the POCS = $1,739

Conservatively assuming vehicle costs are linearly related to total mileage the cost for hauling to and from the landfill

= 0.25 ($4,415) + 0.55 ($1,739)
= $1,104 + $956
= $2,060/week (1981 $)

plus tipping fee cost (from Port Orange budget) = $1,152/week

total weekly cost = $3,212/week
and assuming 327 tons/week(1) (fiscal 1981 average)
total direct haul cost = $ 9.82/ton (1981 $)

(1) This estimate comes from the "Solid Waste Disposal Study for the City of Port Orange", Briley, Wild and Associates, 12/12/79.